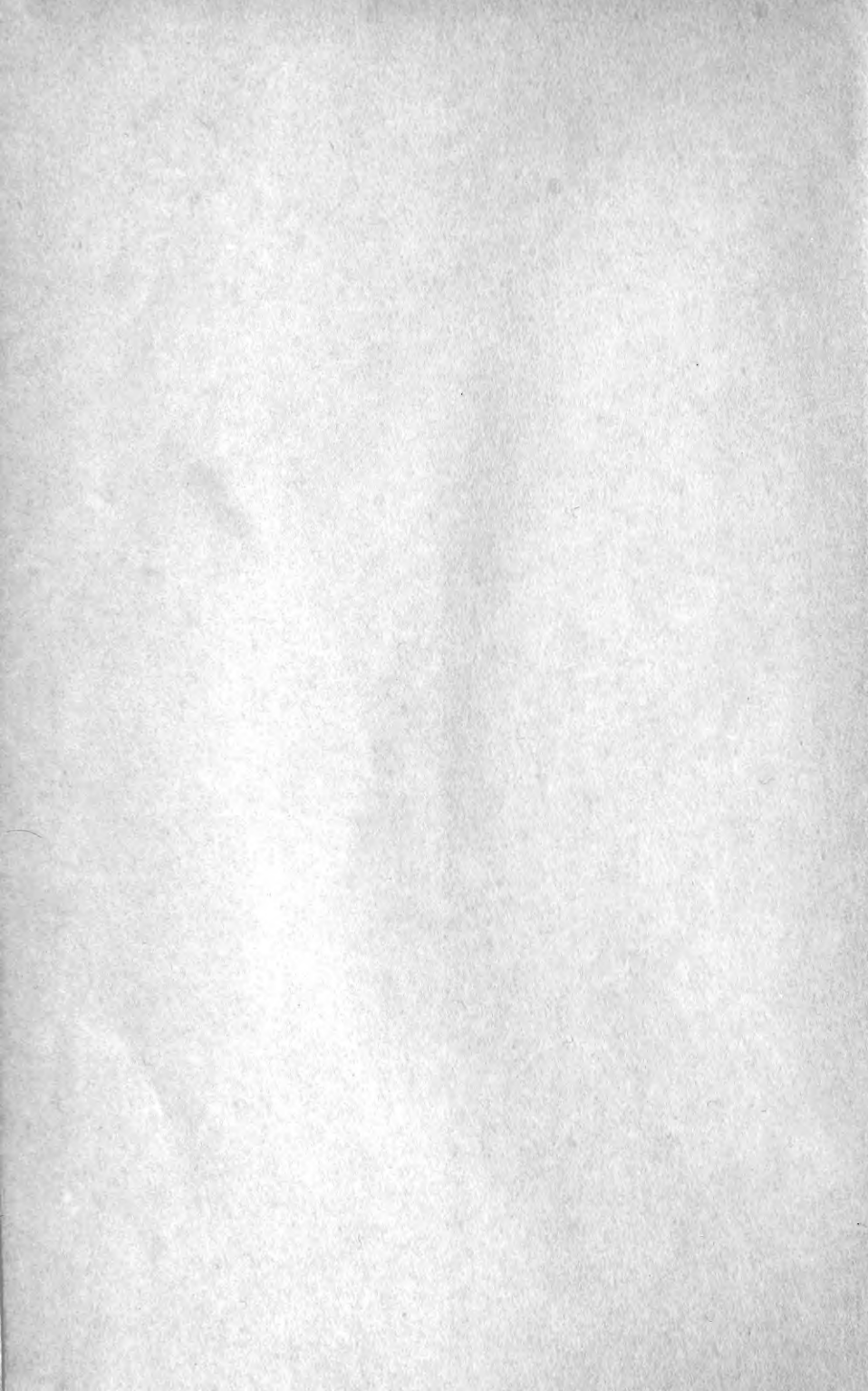


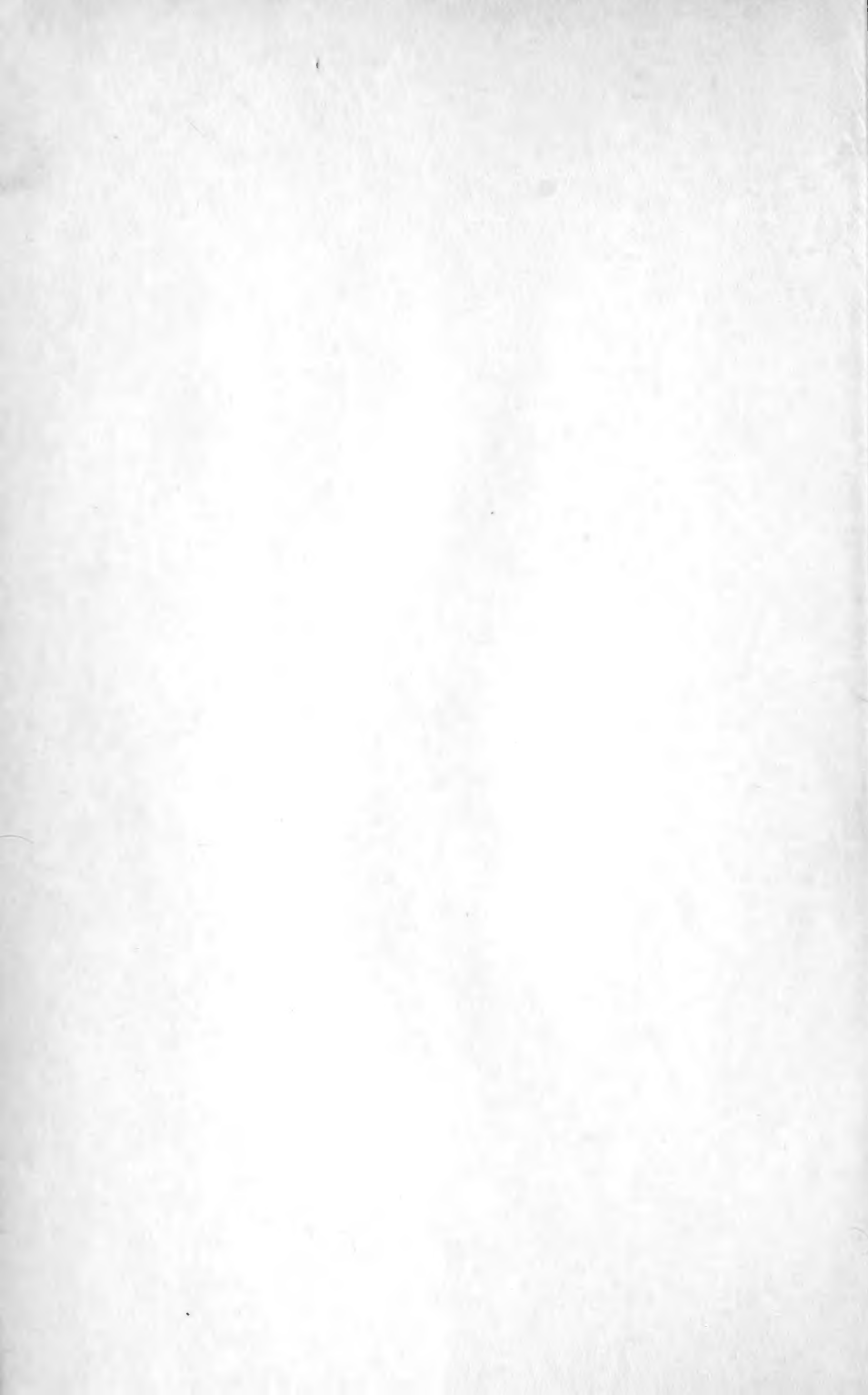
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ALLAN HANCOCK PACIFIC EXPEDITIONS

VOLUME 23

COMPLETE

PECTINIDAE OF THE EASTERN PACIFIC

(PLATES 1-57)

BY
GILBERT GRAU

UNIVERSITY OF SOUTHERN CALIFORNIA PRESS
LOS ANGELES, CALIFORNIA
1959



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ALLAN HANCOCK FOUNDATION
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ERRATA

- p. 21, line 20. For *Pseudamussium tigerinus* read *Pseudamussium tigerinum*.
- p. 48, line 21. For *Chalmys (Pseudamussium) vitrea* read *Chlamys (Pseudamussium) vitrea*.
- p. 53, line 13 from bottom of page. For *Chalmys (Palliolum?) groenlandica* read *Chlamys (Palliolum?) groenlandica*.
- p. 83, line 5. For (? = *Chlamys patagonicus* King, 1831) read (? = *Chlamys patagonica* King, 1831).

PREFACE

Since 1931 the Allan Hancock Pacific expeditions have been concerned with the marine fauna of the west coasts of North and South America, collecting from Oregon to Peru and the Galapagos Islands. Among the many results of scientific importance is an extremely large assemblage of molluscan material, undoubtedly the most comprehensive in existence from the area.

The author immediately consented when Dr. Norman T. Mattox, of the Hancock Foundation, asked him to identify the many specimens of Pectinidae in the Foundation collection, for the opportunity to study such a wealth of regional material was both welcome and valuable to one especially interested in that family. After the identifications were completed, Dr. Mattox suggested the preparation of a report on the material. Since twenty-six of the forty-eight previously described eastern Pacific species were represented, as well as seven new species, the author recommended enlarging the scope of the paper so as to present a systematic study of the entire fauna. As in any undertaking of this kind, the assistance of other workers was needed; the author was fortunate in having the cooperation of those mentioned below.

Of the Foundation staff, Dr. John S. Garth, Dr. Olga Hartman and Dr. Mattox assisted in various ways. Mrs. Dorothy M. Halmos, the librarian, and her assistant, Miss Mary Ellen Pippin, were most helpful throughout the preparation of the paper, for the remarkably extensive Foundation library filled the majority of the author's needs in reference material. Mrs. Halmos also verified many of the references appearing in the paper, edited the paper, and contributed valuable suggestions.

Dr. Harald A. Rehder, of the U. S. National Museum, compared specimens of several of the new species with the holotypes of related species, loaned specimens from the type-lots of two species, supplied photographs of five species (two of which had never been figured), and sent the author 139 lots of material from the Museum collection for identification. Dr. A. Myra Keen, of Stanford University, provided important data, photographs of *Pecten magnificus* Sowerby and *Pecten (Leptopecten) euterpes* Berry, and permitted the author to examine the Stanford collection. Dr. E. L. Bousfield, of the National Museum of Canada, loaned type-lot specimens of *Pecten andersoni* Dall. Dr. Vicente Conde, of the Redpath Museum, McGill University, Montreal, supplied

a photograph of the holotype of *Pecten squarrosus* Carpenter. Dr. S. Stillman Berry, of Redlands, California, presented the author with a type-lot specimen of *Pecten (Leptopecten) euterpes* Berry. Mr. John Q. Burch, of Los Angeles, at whose suggestion the author first began studying the family Pectinidae, was, as he has always been, generous with material, information and advice. Dr. Howard R. Hill, of the Los Angeles County Museum, gave the author access to the Museum collection and had him identify material. Mr. Emory P. Chace, of the San Diego Museum of Natural History, contributed valuable ecological data. The assistance given by each of the above is deeply appreciated.

The author is especially grateful to two friends: Dr. Leo G. Hertlein, of the California Academy of Sciences, San Francisco, and Prof. F. K. North, formerly with the University of Vancouver and now living in San Mateo, California. Dr. Hertlein, who has studied the Pectinidae for many years, and contributed greatly to our knowledge of the family, supplied reference data, discussed many taxonomic problems, and made many helpful suggestions. Prof. North's generic revision, *The Fossil and Recent Pectinidae, Their Origin, Development, Distribution and Classification*, to date unpublished, is a superb and most comprehensive work, and was a major influence on certain of the conclusions reached regarding generic problems.

The plate figures, unless otherwise credited, are the work of Mr. Merwin Slawson, Santa Maria, California.

Captain Allan Hancock's interest in marine research and generosity in providing the means for its furtherance have enormously benefited that branch of the natural sciences, and the author adds his acknowledgment of gratitude to those previously expressed by many other workers.

INTRODUCTION

The Pectinidae are a large and heterogeneous family of marine pelecypod mollusks, world-wide in distribution, having a known geological history dating from the Triassic period, and recorded living at a maximum depth of 2463 fathoms.

As in other molluscan families, a great many taxonomic problems exist, problems which can be satisfactorily solved only by the correlated efforts of geologists, malacologists and conchologists. A monographical treatise on the Pectinidae is needed, of course, but the size and diversity of the family are such that even a work dealing with only the living species would take many years to complete. The more practical alternatives are either generic monographs or papers on the fauna of various regions.

Since this paper had its inception in a study of the Hancock Pacific expeditions material, it concerns the fifty-four species of Pectinidae known to be living in the eastern Pacific, seven of which were previously unknown and are described herein. Because of synonyms involved it was also necessary to include two species definitely extra-limital and one almost certainly so. The first two are *Cyclopecten* (*Delectopecten*) *greenlandicus* (Sowerby) and *Pecten* (?var.) *squarrosus* Carpenter; the third is *Semipallium zeteki* (Hertlein).

As used in this paper, the term eastern Pacific refers to the coastal waters of North and South America, limited on the north by Bering Strait, on the south by the Strait of Magellan, and along most of its western boundary by the Eastern Pacific Barrier of Ekman (1935, p. 105; 1953, p. 72. Also Sverdrup, Johnson & Fleming, 1942, pp. 803, 860-861, fig. 220). The Barrier, ". . . the pelagic and abyssal region between outermost Polynesia and America . . ." (Ekman, 1953, p. 72), has effectively prevented migration of all but a few marine animals. A line drawn from Easter Island to the Hawaiian Islands indicates the approximate eastern limit of the Polynesian region. A line drawn from 60° south and 80° west to Clipperton Island, from there to the central Aleutian Islands and then to Bering Strait, indicates the approximate western boundary of the eastern Pacific.

This paper is a revision of the genera and species of Pectinidae native to the eastern Pacific and a report on the material of that family resulting from the Hancock Pacific expeditions. The study material used in its preparation consisted of the Hancock Foundation collection (containing twenty-six of the forty-eight previously described species and seven new species), the eastern Pacific portion of the author's collection (containing forty-one of the previously described species and including paratypes of twelve species), the Los Angeles County Museum collection, and type-lot specimens borrowed from the U.S. National Museum and the National Museum of Canada. Specimens of some species were also examined in the collections of the California Academy of Sciences (San Francisco), Stanford University and the San Diego Museum of Natural History.

Undoubtedly some persons will disagree with certain of the author's conclusions. Contemporary systematics being a field too large in scope for thorough discussion here, he can only claim to have relied on carefully considered judgment in reaching those conclusions. From the semantic standpoint many of the taxonomic categories we employ are actually philosophical concepts, are subject to interpretation on the basis

of individual opinion, and cannot be objectively defined; the genus, subgenus and subspecies are particularly arbitrary and subjective categories, the species considerably less so. The taxonomic procedures followed in the paper are outlined below.

NOMENCLATURE: Problems concerning the validity of generic and specific names have been resolved by strict observation of the International Code of Zoological Nomenclature and the Opinions of the International Commission on Zoological Nomenclature. Although logical arguments against rigid application of the Law of Priority have been frequently presented, order and unity in taxonomy can be maintained only by strict compliance with the Law until it is officially modified.

GENERA: Unless otherwise indicated, all units were originally proposed as genera. Synonyms which are also homonyms are preceded by [non]. For each unit, including those synonymized, the type-species and type locality are given. For the units regarded as valid, the original diagnosis is given, an additional diagnosis by the present author, remarks, and a list of representative species.

SPECIES: The generic and specific names in synonymies are primarily those necessary to illustrate the nomenclatural history of each species; repetitions of the same combinations of names are cited only when an author gave the first figures of a species or when he contributed further geographical or geochronological data. Misidentifications or synonyms which are also homonyms are preceded by [non]. For each species regarded as valid, the present location of the holotype is given, the type locality, the original description, an additional description or descriptive notes by the present author (except in a few cases), remarks, the known geographical, geochronological and bathymetric ranges, ecological data, and the Hancock expeditions stations at which the species was found.

REFERENCES: To ensure the accuracy of references cited, all but four of the publications in which they originally appeared were examined by Mrs. Dorothy M. Halmos, librarian for the Hancock Foundation, or by the author. Most of the sources were in the Foundation library; of the remainder, some were in the author's library, 12 were borrowed from other libraries, and four volumes not available in this country were examined by fellow workers abroad. The importance of verifying references at their source is proven by the fact that a large number of those cited in the literature were found to be erroneous in one or more respects. In too many instances a slip of the pen or a typographical error was accepted by subsequent authors who did not or could not examine the original source, and thus the error was perpetuated.

Since they have been corroborated, all references in this paper can be relied upon except, of course, any that may have become the victims of undetected typographical errors.

In conclusion the author wishes to quote a remark which seemed singularly apropos at the time this paper was completed. Philip P. Carpenter prepared a report on the mollusks of the west coast of North America for the 1856 meeting of the British Association for the Advancement of Science, and in the opening section of the report he commented, "As human life is so short, and those who have the inclination for scientific pursuits have generally so little leisure, it is a serious evil when so large a proportion of that little has to be devoted to the labour of making out the errors of predecessors." The author agrees, but as an observation rather than a complaint, with due regard for the accomplishments of his predecessors, and with the hope that future workers will not too often find the necessity for "making out the errors" in the following pages.

HANCOCK PACIFIC EXPEDITIONS RESULTS

Intensive collecting in the eastern Pacific by the Hancock expeditions has contributed greatly to our knowledge of the Pectinidae native to the region. Twenty-six of the previously described species were found, many of them represented by series illustrating stages of growth, ecological and individual variations, geographical range and bathymetric range.

The seven new species described in this paper are listed below. Extensions of geographical range were established for eight species, and are listed in approximate mileages; four other extensions of range were based on material not collected by the Hancock expeditions, and they are listed after the above nine.

NEW SPECIES:

Cyclopecten benthalis (southern California)

Cyclopecten zephyrus (southern California)

Cyclopecten acutus (western Colombia)

Cyclopecten exquisitus (Galapagos Islands; Callao, Peru, to northern Gulf of California)

Cyclopecten barbarensis (southern California)

Pecten (*Oppenheimopecten*) *galapagensis* (Galapagos Islands)

Pecten (*Oppenheimopecten*) *hancocki* (Cocos Island, Costa Rica)

EXTENSIONS OF GEOGRAPHICAL RANGE:

Cyclopecten catalinensis (Willett): 45 miles north; first records for Gulf of California.

Cyclopecten pernomus (Hertlein): 330 miles north (in Gulf of California only); 500 miles south; first records for the Galapagos Islands and for Guadalupe Island, Mexico (180 miles west of Lower California).

Chlamys lowei (Hertlein): 130 miles north (in Gulf of California only); 500 miles south; first conclusive record for Santa Catalina Island, California.

Chlamys (Argopecten) circularis (Sowerby): first Recent records for Galapagos Islands.

Chlamys (Leptopecten) latiaurata (Conrad): first record for Gulf of California.

Chlamys (Leptopecten) velero biolleyi (Hertlein & Strong): 800 miles north and 700 miles south.

Pecten sericeus Hinds: 480 miles north and 500 miles south.

Pecten (Oppenheimopecten) vogdesi Arnold: 300 miles north.

The first two of the following extensions of range are based on specimens in the present author's collection, the last three on *Albatross* material in the U. S. National Museum.

Cyclopecten (Delectopecten) vitreus (Gmelin): first record for Clipperton Island (670 miles off southwestern Mexico); previously recorded in eastern Pacific only from off southern Chile.

Chlamys (Leptopecten) velero (Hertlein): 570 miles north.

Cyclopecten bistriatus (Dall): 50 miles north and 880 miles south.

Cyclopecten liriopse (Dall): first record from Galapagos Islands; previously recorded only from type locality in Gulf of Panama.

Cyclopecten (Delectopecten) zacae (Hertlein): 570 miles north.

DATA: Although the most relevant data for those Hancock stations cited are given in this paper, further data, such as latitudes, longitudes and dates, can be found in the following volumes of the series of papers published by the Hancock Foundation under the title Allan Hancock Pacific Expeditions.

DREDGING STATIONS: 1 through 23 and 1-33 through 1502-42: vol. 1, no. 3. Bottom samples (indicated by BS preceding station number):
1 through 587: vol. 6, no. 1.
600 through 651: vol. 6, no. 3.
652 through 667: vol. 6, no. 4.
1001 through 1053: vol. 6, no. 1.

1054 through 1099: vol. 6, no. 3.

1104 through 1176: vol. 6, no. 4.

1177 through 1246: vol. 6, no. 5.

2000 through 2079: vol. 6, no. 1.

2080 through 2141: vol. 6, no. 3.

2142 through 2169: vol. 6, no. 4.

For stations subsequent to 1942, complete data can be obtained from the Allan Hancock Foundation, University of Southern California, Los Angeles 7, California.

KEY TO THE EASTERN PACIFIC GENERA AND SUBGENERA

1. Both valves convex
 2. Without external ribs but almost always with threads, ridges, or rows of scales or vesicles; shell very thin
 3. With internal ribs (except (*Parvamussium*) *davidsoni*)
 4. Without byssal sinus; auricles equal or nearly; convexity slight Genus *Propeamussium*
 4. With byssal sinus; auricles equal; convexity slight Subgenus *Parvamussium*
 3. Without internal ribs
 5. Posterior auricles well-defined; maximum height 10 mm (except *incongruus*: 14 mm); right valve with concentric lamellae or ridges only, and usually flexed ventrally; ctenolium nearly always absent; many species opaque, a few translucent . . . Genus *Cyclopecten*
 5. Posterior auricles poorly defined; their lateral margins continuous with outlines of disks (except *greenlandicus*: oblique); right valve without concentric lamellae or ridges (except in *vitreus*), and never flexed ventrally; ctenolium always present; all species translucent Subgenus *Delectopecten*
2. With external ribs
 6. Ribbing concentric; result of undulations of disks; shell very thin Subgenus *Hyalopecten*
 6. Ribbing radial
 7. Left valve nodose; 9-15 ribs; hinge dentition pronounced and strong diagonal crura adjoining resilial pit Genus *Nodipecten*
 7. Left valve not nodose

8. Shell (right valve) attached to foreign object (by cementation); usually distorted and irregular in outline; right valve deep, left flatter, both quite heavy; byssal sinus obsolete; ribbing coarse and irregular
 Genus *Hinnites* (adult)
8. Shell not attached to foreign object
 9. Both valves quite convex (right deeper than left); moderately thick; 18-21 ribs (except *irradians amplicostata*: 12-15); concentric lamellae in many species, often weak or absent in adult stage; no spinose sculpture
 Subgenus *Argopecten*
 9. Both valves quite flat (right deeper than left); rather thin; 18-22 ribs, broad and flat on right valve, narrow and rounded on left; right valve with fine concentric growth lines, left with very fine concentric lamellae
 Subgenus *Patinopecten*
 9. Both valves moderately convex
 10. Shell translucent or subtranslucent; more than 30 plicate ribs
 Subgenus *Juxtamusium*
 10. Shell moderately thick (except very thin (*Leptopecten*) *latiaurata monotimeris*); 5-100 or more ribs and/or riblets
 11. 17 or more ribs; left valve deeper than right; spinose or imbricate sculpture usually present but no radial striae or concentric lamellae
 . . . Genus *Chlamys*; juvenile *Hinnites*
 11. 5-16 ribs, always plicate; right valve deeper than left
 12. Hinge line very long, longer than disk, same length, or slightly shorter; orbicular or nearly; 9-16 ribs . . . subgenus *Leptopecten*
 12. Hinge line moderately long, more than $\frac{1}{2}$ but less than $\frac{3}{4}$ length of disk; usually higher than long; 9-13 ribs . . . Genus *Semipallium*

12. Hinge line very short, $\frac{1}{5}$ to $\frac{1}{3}$ length of disk; orbicular or nearly; ventral margins often sharply compressed; 5-11 ribs
 Subgenus *Peplum*
1. Only right valve convex; left valve flat or nearly
13. Right valve moderately convex; left valve flat, concave or slightly convex Genus *Pecten*
13. Right valve deeply convex and umbo strongly inflated; left valve convex Subgenus *Oppenheimopecten*

Genus **PROPEAMUSSIUM** de Gregorio 1884

Propeamussium de Gregorio, 1884a, p. 119. [Proposed as a subgenus of *Pecten*.] Type species: *Pecten (Propeamussium) ceciliae* de Gregorio, 1884a, p. 119; type locality: Miocene of Terrebianche, Sicily.—de Gregorio, 1898, pp. 5, 19, pl. 4, figs. 10-14.

Propeamussium de Gregorio (em.), 1883. Dall, 1886, p. 210. [Dall's emendation of *Propeamussium* invalid; date incorrect: de Gregorio's diagnosis written in 1883 but published in 1884. *Pecten fenestratus* Forbes (1844, p. 192) designated as type species; that species herein referred to *Parvamussium*.]

Paramussium Verrill, 1897, p. 72. Type and only species: *Amussium dalli* E. A. Smith, 1885, p. 308, pl. 22, figs. 7, 7a-c [referred to *Variamussium* by Cossmann & Peyrot, 1914, p. 105]; type locality: *Challenger* station 33, off Bermuda, in 435 fathoms.

Pseudopalliorum Oyama, 1944, p. 244. [Error for *Pseudopalliolum*; proposed as a subgenus of *Propeamussium*.] Type species: *Pecten interradiatus* Gabb, 1869, p. 199, pl. 33, figs. 98, 98a; type locality: east of New Idria, San Bernardino County, California (Eocene).

Flavamussium Oyama, 1951, p. 81. [Proposed as a subgenus of *Parvamussium*.] Type species: *Amussium caducum* E. A. Smith, 1885, p. 309, pl. 23, figs. 1, 1a-1c; type locality: *Challenger* station 207, west of Luzon, Philippine Islands, in 700 fathoms.

Luteamussium Oyama, 1951, p. 82. Type species: *Amussium Sibogai* Dautzenberg & Bavay, 1904, p. 207, text-figs. 1-4; type locality: *Challenger* station 12, Celebes Sea, in 289 meters.

Original diagnosis (and description of type species): Conchiglia estremamente tenue e compressa; con superficie interna ed esterna levigata. . . . La scultura consiste in filetti lineari sottilissimi, concentrici, e raggianti; nella regione periferica sono essi quasi del tutto cancellati,

solo ve ne rimane qualcuno dei concentrici confondentesi con i segni di accrescimento. I filetti raggianti sono distinti nella regione umbonale. Ciò che è più caratteristico in questa specie sono circa 9 raggi rossi color sangue, larghi abbastanza, quasi quanto gl'interstizi. Detti raggi non sono punto prominenti all'esterno (nè a quanto pare) all'interno, se se ne toglie forse parte della regione umbonale.—Essi non sono nè costa, nè mere zone colorate; affettano l'interna struttura e si possono isolare del resto della conchiglia come altrettante stecchette sottili.

La valva destra è appena convessa quasi piana; i raggi restano incastrati nella parte interna, ma traspaiono; essi stanno nella regione umbonale, arrivano alla mediana senza però attraversarla tutta.

La valva sinistra è ancor più piana; infatti è appena appena convessa nella regione umbonale, del resto è anche un po' concava, ciò però è forse dovuto a compressione subita nel fossilizzarsi. I raggi sono assai più marcati e appariscenti, traversano non solo la regione umbonale, ma anche la mediana.

Ha molto analogia coll'*Amussium lucidum* Jeffr., da cui si distingue per le zone colorate e per la diversa scultura principalmente pei filetti raggianti.

Translation: Shell extremely thin and compressed; with its internal and external surface polished. The sculpture consists of very fine linear threads, concentric and radial; in the peripheral region these threads are almost completely cancellate, though some of the concentric lines are difficult to distinguish from lines of growth. The radial threads are distinct in the umbonal region. More characteristic of this species are about 9 blood-colored red rays, rather wide, almost as wide as the interspaces. These rays do not project at all from the exterior, nor from the interior either, it would seem, if part of the umbonal region is, perchance, left out of consideration. They are neither costae nor mere colored zones; they affect the internal structure and they can be separated from the rest of the shell like so many thin, delicate sticks.

The right valve is barely convex, almost flat; the rays, though transparent, are firmly fixed to the inner part; they are to be found in the umbonal region and go as far as the middle, but without completely crossing it.

The left valve is even flatter; in fact, it is hardly at all convex in the umbonal region, and as for the rest, it is even a little concave, but that perhaps is due to the compression undergone during fossilization. The rays are much more marked and visible; they traverse not only the umbonal region, but also the middle.

It much resembles *Amussium lucidum* Jeffr., from which it is distinguished by the colored zones and by the diverse sculpture, principally the radiating threads.

Additional diagnosis: Shell thin, flattish, gaping laterally, and usually higher than long; right valve flexed near ventral margin; auricles of equal or near-equal size; no byssal sinus. Sculpture absent on some species; when present, consisting of fine concentric and/or radial threads. Internal lirae reaching to about center of disk, occasionally farther; lirae always white.

Remarks: De Gregorio's reference to blood-colored red rays must be disregarded. Gale (Grant & Gale, 1931, p. 232-233) commented, "It seems hardly possible that the red color is the original color of the shell, if the Miocene age is correct. It is more probable that the shell had been stained by secondary oxide of iron . . ."

Paramussium is synonymized here because the author feels that, despite the anatomical distinctions of *Amussium dalli* (its type and only species), the shell characters on which the unit was based ally it with this genus.

Pseudopalliorum Oyama was based primarily on the large anterior auricle of the right valve of the type, *Pecten interradiatus*; its other features, however, correspond to *Propeamussium*, and in this case the large auricle is of only specific importance.

From the diagnoses of both *Flavamussium* and *Luteamussium* the present author finds no justification for their existence as supraspecific units; the criteria on which they were based are again regarded as being of only specific value.

For the distinctions between *Propeamussium* and *Parvamussium*, see *Remarks* under the latter.

Propeamussium sensu lato comprises a large number of varied forms, and is in need of much further study. In referring species to *Propeamussium* or *Parvamussium* the author based his conclusions on the species in his collection and the descriptions and figures of others cited under either unit. Nearly all are deep-water species, many being known by only one or several specimens. As more material becomes available, the position of some species will undoubtedly need correction.

KEY TO THE EASTERN PACIFIC SPECIES OF *Propeamussium*

1. With 9 internal lirae *malpelsonium* (Dall)
1. With 11-12 internal lirae *meridionale* (E. A. Smith)

Propeamussium meridionale (E. A. Smith) 1885

Plate 1

[non] *Amussium lucidum* var. *striata* Jeffreys, 1879, p. 562. " 'Porcupine' Exp. 1870, Atl., st. 17a [off Cape Mondego, Portugal, in 795 fathoms]; 'Challenger' Exp. (off Marion I.) station 145; [see below], 1375 fms."

Amussium meridionale E. A. Smith, 1885, p. 316, pl. 24, figs. 1, 1a.

Challenger stations 146, 158, 302 [see *Type locality* and *Geographical range*].

Holotype: British Museum.

Type locality: *Challenger* station 158, 50°1'S, 123°E, southern Indian Ocean (about 1600 miles south of Cape Pasley, south coast of Western Australia), in 1800 fathoms.

Original description: Testa fragilissima, paulo inaequalis, iridescent, pellucida, utrinque anguste hians. Valva dextra liris filiformibus numerosis radiantibus, incrementique lineis concentricis ornata, sinistra magis opaca concentrice lirata, liris tenuissimis, complanatis, sensim accrescentibus. Auriculae subaequales, anticis interdum paulo majoribus. Pagina interna nitida, iridescent, liris tenuissimis undenis instructa, in valva dextra radiatim striata, striis cum liris externis congruentibus.

Var.: Testa liris internis duodenis munita, valva dextra extus cancellata.

This species is slightly oblique, excessively thin, a little inequivalve, pellucid white, and narrowly gaping above on both sides. The right [*left*] or deeper valve is more glossy than the left [*right*], and sculptured with numerous very slender radiating lirae and concentric waves and striae of growth. The other [*right*] valve is ornamented with close-set very fine concentric shallow grooves and depressed ridges. The former under the microscope exhibit a very minute reticulation, each parallel zone of this fine network being connected with the one above and below by elongated meshes passing over the intervening ridges. The auricles are small, at times denticulated above, slightly unequal, the anterior being rather larger than the posterior, or this proportion may be reversed. The beaks are moderately acute, the sides meeting at an angle of about 115 degrees. The valves are glossy, somewhat iridescent within, and strengthened with eleven fine lirae, the longest of which extends about two-thirds across the interior. The right [*left*] valve is also very finely striated, the striae corresponding to the slender lirae of the outer surface.

Length 14 mm., height 14, diameter 4.

The specimens from station 302 present one or two differences from those found at the two other localities. The right [*left*] or deep valve has some of the concentric lines of growth elevated into slender lirae, which, crossing those radiating from the beak, produce a distinctly cancellated surface. Besides this, the valves are strengthened with twelve instead of eleven radiating lirae. However, taking into consideration the exact similarity of the microscopic sculpture of the right [*left*] valve, I believe it advisable to consider this form merely as a variety.

Remarks: Jeffreys examined the *Challenger* specimens before Smith published his report on them, and after his brief description of *Amussium lucidum striata* referred those from Marion Island to his new subspecies. Smith (*loc. cit.*) strongly disagreed, saying, "It is most surprising to me that this species could for an instant be considered as a variety of *Amussium lucidum*. Any one holding such a view must either be wanting in perceptive power or his ideas respecting what are usually regarded as species be very peculiar. If any two species of this genus are to be easily distinguished, those in question are they. *Amussium meridionale* is larger, gapes on both sides, has both valves differently sculptured, a shorter hinge-line, and the posterior auricle in the left [*right*] valve is differently sculptured." Dall (1886, p. 212) also disagreed with Jeffreys, and in speaking of *A. meridionale* said, "It is at all events perfectly distinct from *lucidum*. My impression is that Dr. Jeffreys derived his idea of his variety *striata* from specimens of *A. Pourtalesianum*, var. *striatulum* Dall [*loc. cit.*], sent him by Pourtales; but that when he came to describe it he cited *Challenger* localities and specimens, which on a cursory examination he took to be the same thing, and omitted to mention his West Indian ones. However this may be, the var. *striatulum* mentioned agrees perfectly with Dr. Jeffreys' rather brief description of his variety *striata*, but not with his specimens." Dall's omission of any reference to the "Porcupine" specimens is curious, but whatever their taxonomic position may be, we can safely conclude that they are distinct from *Propeamussium meridionale*.

Geographical range: Known only from the type locality and from *Challenger* stations 146, 40°46'S, 45°31'E (about 1250 miles south of Madagascar), in 1375 fathoms, and 302, 42°43'S, 82°11'W (about 600 miles west of south-central Chile), in 1450 fathoms.

Bathymetric range: Recorded in 1375 to 1800 fathoms.

Ecological data: Found in globigerina ooze at each station.

Propeamussium malpelsonium (Dall) 1908

Plate 2, fig. 1

Amusium (*Propeamusium*) *malpelsonium* Dall, 1908, p. 405, pl. 6, fig. 9.

Amusium malpelsonium Dall. M. Smith, 1944, p. 52, fig. 688 (reproduction of original figure).

Holotype: U. S. National Museum.

Type locality: *Albatross* station 3360, Gulf of Panama, in 1672 fathoms, sand.

Original description: Shell suborbicular, of a dirty white color, very thin and fragile, with small subequal ears, moderately convex; beaks low, prodissoconch small, swollen, slightly irregular, often eroded; left valve with small subequal, minutely concentrically lamellose ears; posterior submargin smooth or only with incremental lines; disk with fine incremental lines crossed by numerous fine radial lines with wider interspaces, increasing by intercalation; these radii are arcuate, slightly convex on the anterior side, and bending gently toward the posterior; the radii are not scaly; right valve flexible toward the ventral margin, the portion beyond the internal lirae slightly reflexed when the valves are closed; ears similar and similarly sculptured, the anterior with no byssal sulcus, though there is a single feeble ray near the submargin and a slight inward flexuosity of the incremental lines; disk regularly concentrically striated, the striae with wider interspaces, the intact surface covered with a thin, dehiscent, coarsely fibrous layer; interior polished, the central part whiter, with nine regular, even white, elevated lirae extending all the way from the umbonal region without noticeable thickening distally; in each valve are also two short auricular crura. Height of shell, 18.2; breadth, 18.5; hinge line, 8.2; diam. 3.4 mm.

Geographical range: Known only from five *Albatross* stations: the type locality in the Gulf of Panama; stations 3374, 3381, and 3361, in the vicinity of Malpelo Island, (off western Colombia), in 1823, 1772, and 1471 fathoms, respectively; and station 3684, about 640 miles north of the Marquesas Islands, in 2463 fathoms.

Bathymetric range: Recorded in 1471 to 2463 fathoms, the latter depth being the greatest from which any species of Pectinidae is known.

Ecological data: Found in sand, mud, or ooze.

Subgenus **PARVAMUSSIUM** Sacco 1897

- Parvamussium* Sacco, 1897a, p. 102. [Proposed as a subgenus of *Amusium* Herrmannsen, 1846, p. 47 (invalid emendation of *Amusium* Röding, 1798, p. 165); no diagnosis given but type species designated.]—Sacco, 1897b, p. 48 [diagnosis]. Type species: *Pecten (Pleuronectes) duodecim-lamellatus* Bronn, 1832, p. 624; type locality: Upper Miocene of Tabbiano, Italy.
- Variamussium* Sacco, 1897a, p. 102. [Proposed as a subgenus of *Amusium* Herrmannsen; no diagnosis given but type species designated.]—Sacco, 1897b, p. 49 [diagnosis]. Type species: *Amussium cancellatum* E. A. Smith, 1885, p. 315, pl. 23, figs. 8, 8a-8c; type locality: *Challenger* station 33, off Bermuda, in 435 fathoms.
- Ctenamusium* Iredale, 1929, p. 164. Type species: *Amusium thetidis* Hedley, 1902, p. 304, fig. 49; type locality: off Port Kembla, New South Wales, Australia, in 63-75 fathoms.
- Glyptamusium* Iredale, 1939, p. 370. [Proposed as a genus in the family Amusiidae.] Type species: *Amussium torresi* E. A. Smith, 1885, p. 311, pl. 23, figs. 3, 3a, 3b; type locality: *Challenger* station 1858, east of Cape York, Queensland, Australia, in 155 fathoms.
- Xenamussium* Oyama, 1944, p. 244. [Proposed as a subgenus of *Propeamussium*.] Type species: *Pecten hoskynsi* Forbes, 1844, pp. 146, 192; type locality: "Off Asia Minor."
- Squamamussium* Oyama, 1944, p. 245. [Proposed as a subgenus of *Propeamussium*.] Type species: *Amussium squamigerum* E. A. Smith, 1885, p. 312, pl. 23, figs. 5, 5a; type locality: *Challenger* station 24, off Culebra Island (off eastern Puerto Rico), in 390 fathoms.
- Polynemamussium* Habe, 1951, p. 72. [Proposed as a subgenus of *Parvamussium*.] Type species: *Pecten intuscostatus* Yokoyama, 1920, p. 156, pl. 13, figs. 9, 10; ? type locality; (Japanese species).
- Bathyamussium* Oyama, 1951, p. 79. [Proposed as a subgenus of *Ctenamusium*.] Type species: *Amussium jeffreysii* E. A. Smith, 1885, p. 310, pl. 23, figs. 2, 2a-2c; type locality: *Challenger* station 210, Philippine Islands, in 375 fathoms.
- Micramussium* Oyama, 1951, p. 80. [Proposed as a subgenus of *Ctenamusium*.] Type species: *Ctenamusium (Micramussium) siratama* Oyama, 1951, p. 80, pl. 13, figs. 5-7; type locality: off Manazuru-zaki, Sagami Sea, in 159-128 fathoms.

Original diagnosis: Si distingue dei tipici *Amussium* specialmente per la mole minore e per le coste interne più rare, non appiate, incrassate, non raggiungenti il margine. Questo gruppo è largamente rappresentato allo stato vivente come mostra il "Report of the Lamellibranchiata collect. by Challenger" dello Smith. E gruppo affinissimo ai *Propeamussium* coi quali anzi parmi collegarsi con forme ai passaggio a coi quali a rigore si potrebbe anche reunire.

Translation: It is distinguished from the typical *Amussium* especially by the smaller umbo and by the internal ribs which are less numerous, not flattened, thick, and not extending to the margin. This group is largely represented in the living state as shown in the "Report . . . Challenger" of Smith. It is a group very close to *Propeamussium*, with which it seems to me to be allied because of the form of the hinge, and with which, strictly speaking, it could even be united.

Additional diagnosis: Shells thin, more convex than *Propeamussium*, usually orbicular or nearly so, occasionally higher than long; valves seldom gaping laterally; right valve usually flexed ventrally; auricles moderately to quite unequal; byssal sinus from moderate size to near obsolescence. Right valve usually with concentric ridges only, but in several species radial only, or both; left valve radially ridged in most species, and ridges usually rather prominent; fine concentric ridges frequently present also; radial rows of vesicles only, in several species. Internal lirae reaching almost to ventral margin in most species; lirae not present in *davidsoni* Dall, and frequently absent in *hoskynsi* Forbes.

Remarks: *Parvamussium* differs from *Propeamussium* s.l. chiefly in the presence of a byssal sinus, inequality of the auricles, greater convexity of the disk and, in all but one or two species, the stronger sculpture of the left valve. The number and length of the internal lirae and the lateral gape of the valves are features actually too variable to be of value as criteria.

Dall referred *Variamussium* to *Propeamussium* (1898, p. 698), but nearly all subsequent authors have regarded the former unit as a synonym of *Parvamussium*. Cossmann & Peyrot (1914, p. 105) referred the type of *Paramusium*, *Amussium dalli*, to *Variamussium*; see *Remarks* under *Propeamussium*.

Ctenamusium is synonymized here because Iredale's diagnostic criteria actually serve to unite that unit with *Parvamussium*. Also, its type, *Amusium thetidis*, is clearly referable to the latter.

From Iredale's diagnosis of *Glyptamusium* no apparent reason can be seen for considering it distinct from either *Propeamussium* or *Parv-*

amussium, but its type, *Amussium torresi*, was very logically referred to *Parvamussium* by Oyama (1944, p. 252).

Xenamussium and *Squamamussium* of Oyama are synonymized because the present writer finds nothing in their diagnoses to separate them from *Parvamussium*. Speaking of the type of the former, *Pecten hoskynsi*, Oyama (1951) said, "Whilst *Pseudopalliorum* is allied to *Delectopecten*, having internal lirae, this subgenus resembles *Cyclopecten* Verrill as distinguished from the former." First, *Delectopecten* does not have internal lirae; second, *Pecten hoskynsi* almost always has them, although Oyama did not mention them in his diagnosis of *Xenamussium*.

As to *Polynemamussium* Habe, its type, *Pecten intuscostatus*, is only specifically distinct from *Propeamussium* (*Parvamussium*) *alaskense*, a representative species of *Parvamussium*.

After his diagnosis of *Bathyamussium* Oyama (1951) said, "The shape and sculpture is more like that of *Variamussium*, but the presence of a byssal sinus suggests that it should be placed in *Ctenamusium*." Actually, the byssal sinus of *Amussium jeffreysii*, the type of *Bathyamussium*, is almost obsolete, while that of *A. cancellatum*, the type of *Variamussium*, is certainly more pronounced, even though not very deep.

Micramussium was based on characters of only specific value, and there seems to be nothing in its diagnosis to justify its existence as a subgenus.

In addition to the type, the following species are regarded by the author as being referable to *Parvamussium*: the eastern Atlantic *hoskynsi* and *fenestratum* of Forbes, *sublucidum* and *hypomeces* of Dautzenberg & H. Fischer and *lucidum* Jeffreys; the western Atlantic *holmesii*, *sayanum*, *thalassinum* and *pourtalesianum* of Dall and *cancellatum* E. A. Smith; the eastern Pacific *alaskense* and *davidsoni* of Dall; the western Pacific *ina*, *lacteum*, *zoniferum*, *texturatum*, *cristatellum* and *margaritiferum* of Dautzenberg & Bavay, *jeffreysii*, *torresi* and *squamigerum* of E. A. Smith, *thetidis* and *salcon* of Iredale, *siratama* and *rubrotinctum* of Oyama, *cmadoritinctum* Kuroda and *intuscostatum* Yokoyama; the Indian Ocean *manaricum*, *solitarium* and *investigatorium* of E. A. Smith; the Antarctic *octodecim-liratum* of Melvill & Standen.

See the last paragraph of *Remarks* under *Propeamussium* in regard to the position of the above species.

KEY TO THE EASTERN PACIFIC SPECIES OF *Parvamussium*

1. With internal lirae *alaskense* (Dall)
1. Without internal lirae *davidsoni* (Dall)

Propeamusium (Parvamussium) alaskense (Dall) 1872

Plate 3

- Pecten (Pseudamusium?) Alaskensis* Dall, 1871, p. 155, pl. 16, figs. 4a, 4b. "One lower valve, North Harbor, Unga Island [Shumagin Islands, Alaska], six fathoms, mud, Dall, 1865; one larger living specimen, exactly agreeing, Port Etches, Chugach Gulf, Dr. Minor, U.S. Rev. steamer *Wyanda*. [Port Etches specimen labelled "Type" (by Dall), *fide* Rehder (*in litt.*), 1955.]
- Amusium (Propeamusium) Alaskensis* Dall, 1886, p. 215, pl. 5, figs. 7, 7a. "Only on the Alaskan coast."
- [*non*] *Pecten alaskensis* Dall. Whiteaves, 1887, p. 119. [= *P. Vancouverensis* Whiteaves, *fide* Whiteaves, 1893, p. 134.]
- Pecten alaskensis* Dall. Kobelt, 1888, p. 245, pl. 64, figs. 7, 8. Alaska.
- Propeamusium Alaskensis* Dall. Verrill, 1897, p. 65. Alaska.
- Pecten (Propeamusium) alaskensis* Dall, 1898, p. 711. "Pleistocene of Vancouver Island, near Esquimalt, and at various points in Alaska. Living from Bering Sea to Panama Bay, usually in deeper water."
- Pecten (Propeamusium) riversi* Arnold, 1906, p. 126, pl. 44, figs. 8, 9. Pliocene: Santa Monica canyon, Los Angeles County (Rivers). Pleistocene: Deadman Island, near San Pedro (Arnold).
- Pecten (Propeamusium) levis* Moody, 1916, p. 56, pl. 2, figs. 2a-d. Pliocene: Fourth and Broadway, Los Angeles, California.
- [*non*] *Pecten laevis auct.* (Pennant, Defrance, Nilsson, Potiez et Michaud, Montagu, Turton, Brown, Macgillivray, etc.); all European species.
- Pecten (Propeamusium) alaskense* Dall. Dall, 1921, p. 20. "Pribiloff Islands, Bering Sea, and southward to the Santa Barbara Islands, California. Japan."
- Pecten calamitus* Hanna, 1924, p. 176. New name for *P. (Propeamusium) levis* Moody.
- Pecten (Propeamusium) alaskensis* Dall. Oldroyd, 1924a, p. 62, pl. 12, fig. 3; pl. 38, fig. 6. "Type locality, Pribiloff Islands, Alaska."
- Pecten intuscostatus* var. *multicostata* Yokoyama, 1926, p. 305. Japan.
- [*non*] *Pecten multicostatus* Reeve, 1853, sp. 173, pl. 35, fig. 173. New Zealand. [= *P. zelandiae* Gray, 1843, p. 260.]
- Pecten intuscostatus* var. *sawanensis* Hertlein, 1931, p. 367. New name for *P. intuscostatus multicostata* Yokoyama.

Pseudamussium simanense Kuroda, 1931, pp. 72, 73, figs. 92, 93. Pliocene, Pleistocene and Recent of Japan.

Pseudamussium (Cyclopecten) simanense Kuroda, 1931, p. 81.

Pecten (Propeamussium) alaskensis Dall. Grant & Gale, 1931, p. 234.

"Living: Alaska to Magdalena Bay, Lower California, usually in deep water; Japan." Also previous Pliocene and Pleistocene records.

Polynemamussium alaskense (Dall). Habe, 1951, p. 72.

Propeamussium alaskense (Dall). Kuroda & Habe, 1952, p. 29. Pacific: 39° N—56° N; Japan Sea: 36° N—43° N.

Holotype: U. S. National Museum.

Type locality: Port Etches, Chugach Gulf, Alaska.

Original description: Shell nearly equilateral, inequivalve, flesh-color with a blush of salmon-color on the umbo of the superior valve. Internally white, the salmon-color showing through the valve. Shell suborbicular, barring the auricles, which are wide and prominent. Lower [right] valve flattened, .1 in. [2.5 mm] smaller than the upper one; sculpture of fine, close, equal, concentric ridges, sharply defined and separated by narrow non-canalculated grooves. Valve covered with a fine velvety epidermis, ashy and very finely radiately striate. Surface of the valve, except for the ridges, smooth. Anterior auricle long, prominent, with a deep sinus. Posterior auricle small; both with strong elevated lines of growth, which rise into scales on the eight or nine fine ribs with which the anterior auricle is furnished. Hinge line straight, smooth. Inside of the valve polished, furnished with twenty-one rounded, radiating ribs, with traces of others intercalated near the margin; nodulous or swollen at the more prominent ridges of growth and at the margin.

Upper [left] valve similar, inside; anterior auricle shorter, not so deeply sinuated. Valve more convex than the under one, and a little larger. Dorsal areas finely granulate. Umbo smooth; half way toward the margin the striae of increase become more conspicuous, and about thirty-five pseudo-ribs radiate toward the margin. These are formed by the elevation of the concentric lines of growth like ruffles, in such a way that the edge of one fluting of the ruffle overhangs the beginning of the next, and so on. These are very fragile, and when broken away show the nearly smooth surface of the valve underneath, without any true rib at all. Faint grooves are intercalated between the pseudo-ribs toward the margin. Lon. .76, alt. .76, diam. .22 in., width of hinge line .34 in. Angle at the umbones, 100°. [Height, 19.5 mm; breadth, 19.5 mm; hinge line, 9 mm; diameter, 5 mm; umbonal angle, 100°.]

Additional descriptive notes: Among eastern Pacific specimens the criteria given by Dall are quite constant. Japanese specimens have the

internal lirae of the right valve much less prominent next to the submargins and almost obsolete over the center of the disk; the exterior of the left valve very seldom has any "pseudo-ribs," only faint ridges with very fine concentric lamellae near the ventral margin.

Geographical range: Bering Sea; Aleutian Islands to Magdalena Bay, western Lower California; northern Japan and Korea.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Recorded in 10 to 200 fathoms, possibly living deeper.

Ecological data: None available.

Propeamussium (Parvamussium) davidsoni (Dall) 1897

Plate 4

Pecten Davidsoni Dall, 1897, p. 86. "On the Davidson Bank, Alaska, in 280 fathoms, green mud, and north of Unalashka, in Bering Sea, in 351 fathoms, sand."—Dall, 1902, p. 559, pl. 40, figs. 5, 6. [Same localities.]

Pecten (Pseudamussium) davidsoni Dall. Arnold, 1906, p. 138, pl. 50, figs. 4, 4a. [Same localities as Dall.]—Dall, 1921, p. 20. Davidson and Bowers Banks, Bering Sea.—Oldroyd, 1924a, p. 61, pl. 14, figs. 5, 6. [Figures erroneously referred to *P. randolphi* Dall under that species in text (p. 59) and on plate index opposite plate 14.]

Pecten (Propeamussium) davidsoni Dall. Grant & Gale, 1931, p. 234. Alaska.

Pecten (Pseudamussium) davidsoni Dall. La Rocque, 1953, p. 34. Davidson and Bowers Banks, Bering Sea. Alaska.

Holotype: U.S. National Museum.

Type locality: Davidson Bank (Bering Sea), Alaska, in 280 fathoms.

Original description: Shell small, suborbicular, compressed, waxen white, the left valve with 21 rounded ribs, surmounted by (when not worn off) continuous rows of minute subglobular scales, the interspaces wider, flat and perfectly smooth, ears very small, the anterior with five or six imbricated radii; sculpture obsolete near the umbones; right valve sculptured with faint concentric impressed lines over the whole surface, and distally with numerous minute, obsolete, fine, scaly riblets; posterior ear transversely striated, very small, anterior one with four or five scaly radii, a well-marked sinus leaving an imbricated fasciole and no ctenolium. Interior polished, the left valve fluted in harmony with the external ribs. Alt. 14, lat. 14, diam. 3.5 mm.

Additional descriptive notes: This species is very thin and nearly translucent. The fine ridges near the ventral margin of the right valve are not always present, and between the concentric ridges of that valve are very minute, irregular and discontinuous radial striae. The ribs of the left valve are very low and result from faint plications of the disk; the interspaces are not always smooth, some having one to three faint rows of scales near the ventral margin. The posterior auricles are extremely short, being a little less than half as long as the anterior.

Remarks: Although strongly resembling *Propeamussium alaskense* (Dall) in some respects, this species differs primarily in having no internal lirae and much smaller auricles, secondarily in having the left valve faintly plicate, the rows of scales less numerous, and the scales slightly larger.

The absence of internal lirae would seem to disqualify *Propeamussium davidsoni* from inclusion in *Parvamussium*, but its other features, as well as its close relationship to *Propeamussium alaskense*, justify the inclusion. The lirae are often completely absent in *P. hoskynsi* Forbes, and in *P. alaskense* they are often nearly obsolete, particularly in Japanese specimens. Among externally-ribbed species of Pectinidae an analogy is seen in *Pseudamussium tigrinus* (Müller), (1776, p. 248); that species is usually smooth, but frequently specimens are found having strong plicate ribs.

Geographical range: Reported only from the Bering Sea.

Geochronological range: Reported from the Recent only.

Bathymetric range: Recorded in 274 to 351 fathoms.

Ecological data: Found in sand or mud.

Genus **CYCLOPECTEN** Verrill 1897

Cyclopecten Verrill, 1897, p. 70. Type species: *Pecten pustulosus* Verrill, 1873, p. 14; type locality: near Georges Bank (off Newfoundland), in 150 fathoms. [Massachusetts to Newfoundland; 99 to 547 fathoms.]

Cycloclamys Finlay, 1926, p. 452. Type species: *Pecten transenna* [sic] Suter, 1913, p. 881, pl. 52, fig. 3; type locality: "near the Snares, in 50 fathoms." [South of South Island, New Zealand.]

Original diagnosis: Shells thin, rounded, scarcely oblique, with symmetrical auricles and simple margins. The two valves are quite unlike in sculpture. The right valve is a little flattened and upturned at the flexible margin, so as to fit tightly against the upper valve. The thin

lower valve has, in the typical species, regular, thin, elevated, concentric lamellae, which aid in the adaptation of the edge to that of the upper valve; the margin is usually flattened or bevelled. The upper (left) valve is radially sculptured, rarely smooth; it usually has radial rows of arched scales, pustules, or points, and also concentric raised lines; it is sometimes cancellated. No radial ribs, nor interlocking points at the margin. Auricles well developed, subequal, angulated and well-defined at both ends; byssal notch well defined; few or no pectinidial teeth. Cardinal folds single, rather feebly developed, often cross-lined. Eyes few. Byssus small, and of few threads.

Remarks: Some species do not have the ventral margin of the right valve flexed, and one, *Cyclopecten acutus* sp. nov., does not have concentric lamellae or ridges on that valve. Most species are translucent but a few are opaque.

Cycloclamys Finlay must be disregarded; his diagnosis was based on *Pecten transenna* Suter, but is puzzling in that the criteria do not agree with that species. Actually, *P. transenna* is clearly referable to *Cyclopecten*.

In addition to the genotype and the species included in this paper, others referable to *Cyclopecten* are the eastern Atlantic *imbrifer* (Loven); the western Atlantic *simplex* and *leptaleus* Verrill, *subimbriifer* and *nanus* Verrill & Bush, *reticulus* and *strigillatus* (Dall), and *culebrensis* (E. A. Smith); the New Zealand *transennus* (Suter), *secundus* Finlay and *aupouria* (Powell); the Kermadec Islands *kermadecensis* (E. A. Smith).

KEY TO THE EASTERN PACIFIC SPECIES OF *Cyclopecten*

1. Shell very thin and translucent or subtranslucent; right valve concentrically ridged
 2. Left valve with shallow concave radial fold next to posterior submargin *cocosensis* (Dall)
(Cocos I., Costa Rica; Gulf of Panama)
 2. Left valve with faint radial plications and radial rows of vesicles *benthalis* sp. nov.
(southern California)
 2. Left valve without fold or plications
 3. Surface smooth *catalinensis* (Willett)
(southern California to Cedros I., Lower California;
northern Gulf of California)

3. Entire surface sculptured
 4. Concentric sculpture stronger than radial
 5. Fine concentric lamellae and microscopic radial striae *bistriatus* (Dall)
(southern California; Lower California)
 5. Prominent concentric lamellae and finer radial ridges *barbarensis* sp. nov.
(southern California)
 4. Concentric and radial sculpture of approximately equal strength
 6. Very faint striae; umbonal folds sharply angled *subhyalinus* (E. A. Smith)
(off southern Chile)
 6. Fine lamellae; concentric more apparent when shell viewed in upright position, radial more so when viewed from anterior or posterior margin *liriope* (Dall)
(Gulf of Panama; Galapagos Islands)
3. Sculpture on only upper $\frac{1}{3}$ to $\frac{1}{2}$ of disk; minute concentric and radial ridges; disk extremely thin and often with several faint concentric folds . . . *zephyrus* sp. nov.
(southern California)
1. Shell thicker and opaque; right valve concentrically ridged
 7. Left valve with only radial ridges . . . *pernomus* (Hertlein)
(Cedros I., Lower California, and Gulf of California, to Ecuador)
 7. Left valve with only concentric ridges; ridges minute *acutus* sp. nov.
(western Colombia)
 7. Left valve with concentric lamellae and radial ridges
 8. Hinge line short; anterior auricle of right valve with 5 radial ridges *incongruus* (Dall)
(northwest of Cedros I., Lower California)
 8. Hinge line nearly as long as disk; anterior auricle of right valve with 10-12 radial ridges *exquisitus* sp. nov.
(Galapagos Islands; Peru to northern Gulf of California)

***Cyclopecten benthalis* sp. nov.**

Plate 5

Shell quite small, translucent, very slightly higher than long, and equivalve; hinge line about half as long as disk and beaks protruding slightly. Right valve flatly convex, with reflexed ventral margin (about $\frac{1}{5}$ total height of valve); numerous faint concentric ridges and, along ventral margin, numerous even fainter radial ridges. Anterior auricle longer than posterior, concentrically lamellose and with 3 distinct radial ridges; byssal notch shallow and no ctenolium. Posterior auricle small, with perpendicular margin and covered by fine concentric lamellae. Left valve moderately convex and radially corrugated, resulting in 13 low primary ridges with a few irregularly disposed secondary ridges between some of them, 9 secondary ridges adjoining anterior submargin and 7 adjoining posterior; minute subglobular vesicles on primary ridges, about $\frac{1}{2}$ mm apart. Auricles of same size as corresponding ones of right valve; both with fine concentric lamellae and 6 very faint radial ridges.

Holotype: Height 8 mm; length 7.5 mm; diameter 1.75 mm; hinge line 3.9 mm; only specimen known. Allan Hancock Foundation.

Type locality: 14.5 miles NNW of San Nicolas Island, California, in 490 fathoms, gray-green mud, tubiculous annelids, foraminiferans, *Phyllochaetopterus* sp.; Hancock station 3031-55; 33°28'04"N, 119°34'41"W; May 7, 1955.

Remarks: Although it is seldom advisable to describe a new species on the basis of a single specimen, the author feels justified in this instance.

The short hinge line and the ridges and sculpture of the left valve distinguish this species from any other Pacific *Cyclopecten*. In general aspect it resembles the Atlantic *C. imbrifer* (Loven) (1847, p. 185), but that species differs in having larger anterior auricles with more numerous radial ridges, imbricated posterior auricles, no fine radial ridges on the right valve and more numerous and more profusely sculptured radial ridges on the left valve.

***Cyclopecten subhyalinus* (E. A. Smith) 1885**

Plate 6

Pecten subhyalinus E. A. Smith, 1885, p. 304, pl. 22, figs. 2, 2a. [Off southern Chile.]

Cyclopecten subhyalinus (Smith). Verrill, 1897, p. 71; Antarctic.

Holotype: British Museum.

Type locality: *Challenger* station 310, off southern Chile, in 400 fathoms, blue mud; $51^{\circ} 27' 30''$ S, $74^{\circ} 3'$ W.

Original description: Testa compressa, tenuissima, vitrea, nitida, aliquanto inaequivalvis; valva sinistra paulo convexior, fere laevis, striis paucis concentricis aliisque radiantibus sculpta; valva dextra striis concentricis regularibus ornata. Auriculae inaequales, bene definitae, anticis paulo majoribus, illa valvae dextrae radiatim lirata, mediocriter profunde sinuata. Margo valvae infra sinum rectilinearis, haud denticulatus.

Length 7 mm., height $7\frac{1}{2}$, diameter 2.

Additional description: Shell small, moderately compressed, translucent, shining and inequivalve. Sharp umbonal ridge from beak to point where submargin meets ventral margin. Left valve moderately convex, with distant concentric and radial striae. Right valve with more pronounced concentric striae. Auricles unequal, distinct, anterior ones larger. On right valve anterior auricle has a few radiating lirae, posterior auricle with moderately deep byssal notch and with concentric striae. Faint concentric striae on both auricles of left valve.

Remarks: Known only from the type locality.

***Cyclopecten zephyrus* sp. nov.**

Plate 7, figs. 1-3

Shell small, extremely thin, translucent, inequivalve and equilateral, adult specimens averaging 8 mm in height and length; hinge line more than half as long as disk, with beaks protruding slightly above. Right valve moderately convex, with ventral $\frac{1}{4}$ of disk thinner and reflexed; 55 to 75 fine concentric ridges covering disk, with very minute and irregular radial striae between them; extremely thin outer layer of shell present on some specimens, but apparently always worn off to some extent; anterior auricle moderately large and longer than posterior, with fine concentric ridges; lower half of auricle with convex fold; byssal notch shallow and no ctenolium present; posterior auricle with nearly perpendicular lateral margin, and very finely sculptured by continuations of discal ridges. Left valve more convex than right, and occasionally with one or two faint concentric folds in umbonal area; very fine and widely spaced concentric ridges and slightly stronger and irregular radial ridges often present on upper $\frac{1}{3}$ to $\frac{1}{2}$ of disk; auricles of same length as those of right valve, and both with fine concentric ridges.

Holotype: 9 mm in height and length; diameter 1.75 mm; hinge line 5 mm; Allan Hancock Foundation.

Type locality: 5.5 miles off Long Point, Santa Catalina Island, California, in 400-430 fathoms, gray-green mud; Hancock station 1613-48; October 2, 1948.

The species also occurred at 16 additional Hancock stations off southern California; of the 17 stations, 13 were in the San Pedro Basin (between the mainland and Santa Catalina Island), 2 just north of the basin and 2 just west of the island.

Remarks: This is the thinnest and most fragile species of Pectinidae known to the author. The reflexed ventral portion of the right valve is even thinner than the rest of the disk, and it is impossible to separate the valves without that portion breaking off.

On the left valve of many specimens a deep water serpulid is found: *Protis pacifica* Moore (1923, p. 253). From one to five specimens may be living on a single valve, ". . . usually directed so that the oral aperture of the annelid is at or near the siphonal end of the mollusk." (Hartman, 1955a, p. 52)

Geographically this species seems to be unusually restricted, for the stations at which it was found were all within an area bounded by north latitudes $33^{\circ} 14'$ and $35^{\circ} 54' 09''$, west longitudes $118^{\circ} 17' 58''$ and $119^{\circ} 10' 15''$. Apparently it does not range very far beyond the above limits, for it has not occurred in any of the extensive collecting by Hancock expeditions in adjacent areas.

Its bathymetric range is also rather restricted, the minimum depth recorded being 400 fathoms, the maximum 620.

The 13 San Pedro Basin stations were all located in an area of impoverished fauna which was described and discussed by Hartman in 1955b. At the stations in that area the species was found at from 400 to 495 fathoms in gray-green mud, associated with foraminiferans, *Protis pacifica*, two or more species of the annelid *Phyllochaetopterus* and, occasionally, glass sponge. At the other four stations it occurred at from 445 to 620 fathoms in gray-green mud, associated with foraminiferans and various annelids.

Cyclopecten subhyalinus (E. A. Smith), known only from off southern Chile, is similar to this species, but differs in being less compressed, not having a convex fold on the anterior auricle of the right valve, having distinct radial lirae but not concentric ridges on that auricle, radial and concentric ridges over the entire surface of the left valve, and possessing a deeper byssal sinus.

Hancock Expeditions Collecting Stations:

SAN PEDRO BASIN (between southern California mainland and Santa Catalina Island): stations 1613-48, 2303-53, 2327-53, 2330-53, 2332-53, 2333-53, 2363-53, 2388-53, 2420-53, 2422-53, 2740-54, 2800-54, 2801-54, 400-495 fathoms.

NORTHWEST OF SAN PEDRO BASIN: sta. 2964-54, 490 fathoms; 3020-55, 445 fathoms.

WEST OF SANTA CATALINA ISLAND: sta. 2850-54, 620 fathoms; 2970-54, 476 fathoms.

Cyclopecten liriopae (Dall) 1908

Plate 8, fig. 1

Pecten (Pseudamusium) liriopae Dall, 1908, p. 402.

Pecten (Delectopecten) liriopae Dall. Hertlein, 1935, pl. 18, fig. 16.

Photograph of holotype.

Pseudamusium liriopae Dall. M. Smith, 1944, p. 52.

Holotype: U. S. National Museum.

Type locality: *Albatross* station 3392, Gulf of Panama, in 1270 fathoms.

Original description: Shell small, fragile, whitish, subcircular; convex (left) valve with small subequal ears finely concentrically lamellose; disk with extremely fine, close, radial threads with nearly equal interspaces; crossed by fine concentric lamellae, with wider interspaces, more distant on the beaks, closer toward the margin; interior glassy, the sculpture shining through; right valve similarly sculptured, except that the radial threads are obsolescent and the concentric lamellae more obvious; anterior ear longer with a wide byssal sulcus and fasciole, a single radial thread bordering the fasciole; margin of the disk flexible. Alt. 7.5; lat. 8.0; hinge line, 4.5; diam. 2.5 mm.

A peculiar thing about the sculpture of this little shell is that, looked at in one light, only the radial, in another only the concentric sculpture is visible, and thus there is no effect of reticulation to speak of, yet there is little difference in the strength of the two kinds of sculpture.

Remarks: Dall used the terms "white" or "whitish" in describing several species which are, like this, actually transparent. Unless the small deep-water shells of this family are separated and washed, thorough study and accurate description are impossible.

This species was previously recorded only from the type locality. Dr. Harald A. Rehder sent the author some unidentified *Albatross*

material from the U.S. National Museum collection, and *C. liriopæ* was found to be present from station 2807, near the Galapagos Islands, in 812 fathoms.

***Cyclopecten bistriatus* (Dall) 1916**

Plate 8, fig. 2

Pseudamusium bistriatum Dall, 1916, p. 404.

Pecten (Pseudamusium) bistriatum Dall. Dall, 1921, p. 20. [Original record cited.]

Holotype: U. S. National Museum.

Type locality: U. S. Bureau of Fisheries, station 2923, off San Diego, California, in 822 fathoms, green mud.

Original description: Shell small, suborbicular, moderately convex, white, thin; left valve finely concentrically, rather distantly lamellose, the lamellae closer and more conspicuous on the subequal ears; radial sculpture of very fine, close-set, uniform almost microscopic elevated lines, which do not reticulate the lamellations; right valve with the concentric, but without the radial sculpture, concave near the margin, the disk about as convex as the other valve, ears subequal, byssal notch short, acute; one or two faint radii on the ear above it. Height, 7; breadth, 7; diameter, 2 mm.

Additional descriptive notes: Dr. Harald A. Rehder, of the U. S. National Museum, loaned the author three specimens from the type-lot; two were still closed, but one had become separated, and it could then be seen that the shell is actually translucent. The concentric ridges of the left valve are stronger and more apparent than Dall's description indicated.

Geographical range: Santa Barbara Island, California, to Cape San Lucas, Lower California, Mexico. Previously known only from the type locality; in July, 1958, Dr. Rehder asked the author to identify 139 lots of eastern Pacific material from the U. S. National Museum collection; one lot contained specimens of *Cyclopecten bistriatus* from *Albatross* station 2980, between Santa Barbara and San Nicolas Islands, California, in 603 fathoms, green mud, and another lot contained specimens from *Albatross* station 5683, off Cape San Lucas, Lower California, Mexico, in 630 fathoms, green mud. Those records extend the northern range by approximately 50 miles and the southern by approximately 880.

Cyclopecten catalinensis (Willett) 1931

Plate 9, fig. 1

Pecten (*Cyclopecten*) *catalinensis* Willett, 1931, p. 65, pl. 4, figs. 1-2.

—Hertlein & Strong, 1946, p. 61; Catalina Island, California, to Cedros Island, Lower California.

Holotype: Los Angeles County Museum, Los Angeles, California.

Type locality: Off White's Landing, north side of Santa Catalina Island, California, in 100 fathoms.

Original description: Shell small, shining, transparent, very fragile; right valve white, unmarked; left valve with about twenty, somewhat irregular, brown, radial rays, running from the median part of the disk to the margin; these rays show through the transparent shell so plainly that, to a casual inspection, the right valve appears rayed also. Ventral margin of left valve convex; that of right valve flexible and reflexed when closed. Sculpture of left valve consisting of fine growth lines, crossed in the umbonal region by very fine, wavy striae, visible only under a strong lens. Ventral two-thirds of right valve marked by fine, closely spaced, incised, concentric lines, with wider interspaces; similar lines also apparent on the anterior auricle above the rather shallow byssal notch. Ears in both valves nearly equal in size. On the left valve the ridges running from the sides of the shell to the umbo, and dividing the discal from the auricular regions, are so sharply defined as to be almost carinate; these ridges, meeting at the umbo, form the two sides of a perfect triangle.

The type measures in millimeters: height, 7; breadth, 7.5; hinge line, 5; diameter, 1.6.

Additional descriptive notes: An interesting structural feature of the right valve is shared by a number of other species of *Cyclopecten* and *Propeamussium* in which that valve has a reflexed ventral margin: the reflexed portion is thinner than the rest of the disk and so fragile that it breaks off if one attempts to separate the valves of a closed specimen; consequently separated specimens appear to have a smaller right valve.

The largest specimens known measure 9 mm in height and length, and were taken by the Hancock expeditions off Tiburon Island, northern Gulf of California.

Geographical range: San Miguel Island, Santa Barbara Islands, southern California, to Cedros Island, Lower California, Mexico; also off Tiburon Island, Gulf of California. Previous records indicated Santa Catalina Island, California, to be the northern, and Cedros Island

the southern limits; Hancock stations increased the northern range by about 45 miles, as well as furnishing the first proof that this species also lives in the Gulf of California. It seems reasonable to assume that it actually lives along the entire Lower California coast to Cape San Lucas and throughout the Gulf.

Geochronological range: Recorded only from the Recent.

Bathymetric range: Taken at Hancock stations in both lesser and greater depths than previously recorded: 16 to 172 fathoms.

Ecological data: Almost always found in mud, but occasionally in sand.

Hancock Expeditions Collecting Stations:

GULF OF CALIFORNIA: 16-20 fathoms, sand; sta. 566-36, bottom sample 279 (Tiburon Island).

SOUTHERN CALIFORNIA and SANTA BARBARA ISLANDS: 13 stations; 45-172 fathoms, sand or mud. Northern limit: San Miguel Island; 57 fathoms, bottom sample 1234.

***Cyclopecten cocosensis* (Dall) 1908**

Plate 9, fig. 2

Pecten (*Cyclopecten*) *cocosensis* Dall, 1908, p. 405, pl. 6, figs. 1, 3.

"U.S.S. *Albatross*, station 3369, near Cocos Island, Gulf of Panama [*lapsus calami*, Cocos Island, Costa Rica], in 52 fathoms, rocky bottom, temperature 62°.2 F."

[*non*] *Pecten* (*Cyclopecten*) *cocosensis* Dall. Hertlein, 1935, p. 319, pl. 18, figs. 7, 8. = *Pecten pernomus* Hertlein (see that species, this paper), *non* *P. cocosensis* Dall, *fide* Hertlein & Strong, 1946, p. 62.

Cyclopecten cocosensis (Dall, 1908). Keen, 1958, p. 72, fig. 134. "The type locality is Panama Bay, in 52 fathoms, . . ."

Holotype: U. S. National Museum.

Type locality: *Albatross* station 3369, near Cocos Island, Costa Rica, in 52 fathoms.

Original description: Shell small, suborbicular, translucent whitish, irregularly painted with opaque white, red, and ferruginous brown, in lines, zigzags, or clouded patches; there are also visible on the right valve in some of the specimens whitish rays which would give the impression until the interior is examined that the shell belongs to the *Propeamusium* group; ears subequal, small, the anterior larger, in the left valve elegantly minutely reticulated and at the hinge line adorned by a series of small, close-set, short, sharp spines; in the right valve the sculp-

ture of the ears is very similar, but the lines are less close and sharp and the anterior auricle has a deep triangular byssal sulcus, without a noticeable fasciole or a ctenolium; left valve with the umbo sharp, small, and prominent, the disk nearly smooth, with faint radial striae which near the submargins become more regular and sharp, especially behind; right valve with a less prominent umbo, the surface polished, the ventral margin flexible, and reflexed when closed; sculpture of fine, close, regular concentric lines with wider flat interspaces; interior smooth, polished, without radial lirae; the hinge line with two well-marked transversely striated provincular areas. Height of shell, 8.7; breadth, 9.0; hinge line, 5.0; diam. 2.0 mm.

.
The faint white rays on the right valve of this shell look so much like *Propeamusium* that until I separated the valves of one of the specimens I had no doubt it belonged to that group.

Additional descriptive note: Dall failed to mention a very distinctive feature of this species: the shallow concave fold of the posterior portion of the left valve, extending from the umbo to the ventral margin. His figure 1, a drawing, shows this feature, although somewhat exaggerated. *Cyclopecten exquisitus* sp. nov., described in this paper, is the only other species of this genus in which the left valve is similarly flattened.

Geographical range: Reported only from the type locality and from *Albatross* station 2794, Gulf of Panama (off Punta Mala), in 62 fathoms. Incidentally, Dall gave as the type locality "Cocos Island, Gulf of Panama." Cocos Island is actually over 400 miles west (slightly southwest) of the Gulf.

***Cyclopecten acutus* sp. nov.**

Plate 10, fig. 2

Shell very small, rather thin but opaque, glossy, slightly inequivalve and equilateral, largest specimen found (a left valve) measuring 4 mm in height; hinge line usually same length as disk but occasionally somewhat shorter; beaks protruding slightly. Right valve moderately convex (slightly less than left valve) and covered by a thin transparent layer of shell extending beyond entire margin of valve except in center of hinge margin; only sculpture on disk consisting of extremely faint concentric ridges. Anterior auricle very slightly longer than posterior and with numerous fine concentric lamellae; byssal notch rather shallow and no ctenolium. Posterior auricle pointed and finely concentrically lamellose. Left valve moderately convex and covered by same transparent layer of

shell as right valve, layer also extending beyond entire margin except above hinge line; 6 to 8 prominent rows of concentric lamellae on disk in very young stage, in adult stage either faintly present on umbo only or entirely absent; very minute concentric lines of growth on rest of disk. Anterior auricle slightly shorter than that of right valve, with numerous faint radial ridges and 4 or 5 fine concentric lamellae near the beak. Posterior auricle same length as that of right valve and also pointed, having numerous faint radial ridges. Color of right valve: white or yellow-white; left valve: White or yellow-white, with streaks or blotches of yellow or yellow-brown.

Holotype: Height and length 3.75 mm; diameter 1.5 mm; hinge line 3.75 mm; Allan Hancock Foundation.

Type locality: Off north side of Gorgona Island, western Colombia, in 32 fathoms; Hancock expeditions bottom sample 584; February 24, 1938.

The species also occurred in Octavia Bay, western Colombia, in 75 fathoms; Hancock bottom sample 555; January 27, 1938.

Remarks: This species is quite distinct. From its nearest relative, *Cyclopecten pernomus* (Hertlein), it can be separated particularly by its transparent margins but also by its orbicular disk, absence of radial ridges on the left valve, much finer concentric ridges on the right valve and the length and sculpture of the auricles. From *C. cocosensis* (Dall) it differs primarily in the transparent margins and also in the shape of the disk, the absence of radial striae and posterior sulcus on the right valves, and the length and sculpture of the auricles.

***Cyclopecten pernomus* (Hertlein) 1935**

Plate 11

Pecten (*Cyclopecten*) *rotundus* Dall, 1908, p. 404. "Albatross station 2799, in Panama Bay, in 29½ fathoms; also at station 2784 [off southern Chile, 48°41'S, 74°24'W; a single valve], in 194 fathoms, mud, bottom temperature 51° 9 F."

[non] *Pecten rotundus* von Hagenow, 1842, p. 554. Fossil; in chalk on Baltic Sea island of Rügen, Germany.

[non] *Pecten* (*Cyclopecten*) *cocosensis* Dall. Hertlein, 1935, p. 319, pl. 18, figs. 7, 8. San Jose Island, Gulf of California, to Acapulco Bay, Mexico, and near Cocos Island, Costa Rica. = *P. pernomus* Hertlein, non *P. cocosensis* Dall, *vide* Hertlein & Strong, 1946, p. 62.

Pecten (*Cyclopecten*) *pernomus* Hertlein, 1935, p. 320, pl. 18, figs. 11-13. Panama Bay; (?) Straits of Magellan; new name for *Pecten*

(*Cyclopecten*) *rotundus* Dall, not *P. rotundus* von Hagenow.—Hertlein & Strong, 1946, p. 61. Cedros Island, Lower California, to Panama.

Cyclopecten pernomus (Hertlein, 1935). Keen, 1958, p. 72, fig. 135. Cedros Island, Lower California to Panama.

Holotype: U.S. National Museum.

Type locality: Albatross station 2799, Panama Bay, Panama, in 29½ fathoms.

Original description: Shell very small, thin, white, suborbicular, with subequal ears, both valves nearly equally convex; right valve polished, minutely regularly concentrically striated, which sculpture is barely visible under a hand lens; posterior ear smooth, anterior finely radially threaded, with a narrow but clean-cut byssal sulcus and fasciole; left valve finely sharply radially striated, the anterior ear finely reticulated, the posterior apparently nearly smooth; hinge line short, straight; interior smooth, a pair of small auricular crura present; the hinge line with a minute central pit and two relatively large transversely sharply striated, elongate areas representing a permanent provinculum. Height and length, 3; hinge line, 2.5; diameter, 1.0 mm. A single valve from near the Straits of Magellan, apparently the same species, measures 7 mm. in height.

Additional descriptive notes: The right valve is slightly smaller than the left. Its anterior auricle has concentric as well as radial striae; its posterior auricle is not "smooth," having 7 to 11 fairly prominent radial threads and finer concentric threads. The posterior auricle of the left valve is not "nearly smooth," having both fine radial and finer concentric threads. On about half of the hundreds of left valves examined there were gray-brown, yellow-brown, red-brown or deep brown areas, irregular and varying in size; the right valves were all white. Specimens measuring 10 mm in altitude were taken at Hancock station BS2130, Pond Island, northern Gulf of California, in 62-85 fathoms; the largest specimens previously recorded were 7 mm in altitude.

Geographical range: Cedros Island, western Lower California, Mexico, and Angel de la Guarda Island, northern Gulf of California, to La Libertad, Ecuador. Also Guadalupe Island, Mexico (180 miles west of central Lower California) and the Galapagos Islands. Dall's "single valve from near the Straits of Magellan, apparently the same species, . . ." cannot be accepted as conclusive evidence that *Cyclopecten pernomus* actually lives that far south. Previous records indicated San Jose Island as the northern limit in the Gulf of California and Panama Bay

as the southern limit in the Pacific. Hancock station BS2037, north of Angel de la Guarda Island, increased the northern range in the Gulf by about 330 miles; Hancock station BS504, La Libertad, Ecuador, increased the southern range by about 500 miles; Hancock station 155-34 established the first record from the Galapagos Islands.

Geochronological range: Reported only from the Recent.

Bathymetric range: Recorded in 1 to 194 fathoms. Durham (1942, p. 121) reported this species at *E. W. Scripps* station A3599, Sal Si Puedes Channel, Gulf of California (between Lower California and the San Lorenzo Islands), in 860 fathoms, “. . . in the mud, on a mushroom anchor.” Although he did not say whether the specimens were living or dead, it is almost certain that they were not living at that great depth.

Ecological data: Usually found in mud bottoms, occasionally sandy mud or sand; sometimes associated with eel grass or weed.

Hancock Expeditions Collecting Stations:

GALAPAGOS ISLANDS: off Tagus Cove, Albemarle Island; in 50-60 fathoms, rock, nullipores, bryozoa, sta. 155-34.

ECUADOR: La Libertad; 3 fathoms, bottom sample 504.

COLOMBIA: 5 bottom samples; Port Utria to Gorgona Island; 12-60 fathoms.

PANAMA: 4 bottom samples; Secas Islands to Jicarita Island; 12-80 fathoms.

COSTA RICA: Port Culebra; 3-15 fathoms, mud, sta. 253-34, and bottom sample 309.

MEXICO: Tenacatita Bay, Colima; 50 fathoms, bottom sample 217.

CLARION ISLAND, REVILLA GIGEDO ISLANDS, MEXICO: Sulphur Bay; 53 fathoms, bottom sample 223.

GULF OF CALIFORNIA: 24 stations; San Francisco Island north to Angel de la Guarda Island; 1-125 fathoms, sand, mud.

GUADALUPE ISLAND, MEXICO: Melpomene Cove; 34-36 fathoms, sta. 1919-49.

WESTERN LOWER CALIFORNIA: 7 stations; Punta Eugenia north to Cedros Island; 13-44 fathoms, sand.

***Cyclopecten exquisitus* sp. nov.**

Plate 12

Shell very small, largest valve found measuring 6 mm in height and length; rather thin but opaque, inequivalve and inequilateral; beaks closer to posterior margin and protruding a little above; hinge line nearly as long as disk. Right valve of low convexity and slightly smaller

than left; very numerous minute radial ridges crossed by more prominent concentric lamellae which are higher over radial ridges, resulting in scalloped effect; anterior auricle longer than posterior, with 10 to 12 rather faint radial ridges and 20 to 25 rows of more prominent concentric lamellae, the latter produced above hinge margin and appearing in profile as spines; byssal notch moderately deep and no ctenolium; posterior auricle slightly produced, with shallow sinus below, and having 6 major riblets nearest hinge margin, several minor ones adjoining disk, and 8 to 12 rows of concentric lamellae. Left valve moderately convex except for posterior $\frac{1}{3}$ of disk, which is slightly flat or very shallowly concave; 14 to 19 primary radial ridges, with 1 to 4 smaller intercalary ridges between them, intercalaries beginning at various distances from umbonal area; 22 to 40 rows of concentric lamellae, much more prominent than those on right valve and, as on that valve, higher over radial ridges, with resultant scalloped effect; anterior auricle moderately produced, with well-defined sinus below; 8 to 10 low radial ridges and 8 rows of fairly prominent concentric lamellae; posterior auricle slightly produced, with shallow sinus below; 8 low radial ridges and 8 rows of concentric lamellae. Interior of each valve flattened near ventral margin. Both valves white or yellow-white; left valve often with streaks or patches of yellow, brown or red-brown, less frequently red or red-orange.

On the holotype part of the posterior auricle of each valve is broken off, giving the impression that no posterior sinus exists; a number of single valves in perfect condition were found, and they show the actual length of the auricles.

Holotype: Height and length 3.5 mm; diameter 1 mm; hinge line 3 mm. Allan Hancock Foundation.

Type locality: Off Wenman Island, Galapagos Islands, in 100-150 fathoms, coral and nullipores; Hancock station 143-34; $1^{\circ} 23' 10''$ N, $91^{\circ} 48' 45''$ W; January 11, 1934.

Geographical range: Galapagos Islands; Callao, Peru, to Angel de la Guarda Island, northern Gulf of California.

Geochronological range: Recent only.

Bathymetric range: 12 to at least 150 fathoms.

Ecological data: Usually found on sand bottoms, occasionally rock; associated with coral, coralline and nullipores.

Remarks: This beautiful little species is quite distinct from any other eastern Pacific *Cyclopecten*. As it occurred at 45 Hancock stations and is so widely distributed, it seems remarkable that it remained so long undiscovered. While this paper was in press Dr. Harald A. Rehder sent

the author some additional lots of unidentified material from the U. S. National Museum. One lot comprised a number of single valves of *C. exquisitus* taken April 7, 1888, at *Albatross* station 2813, off Hood Island, Galapagos Islands, in 40 fathoms; Dall labelled the specimens "Pseudamussium sp."

Hancock Expeditions Collecting Stations:

GALAPAGOS ISLANDS: Albemarle, Barrington, Charles, Duncan, Gardner, Hood, James, and South Seymour Islands; 22 stations, 12-150 fathoms, sand.

PERU: Callao; 210 fathoms, bottom sample 552 (dead).

COLOMBIA: 8 stations; Gorgona Island to Octavia Bay; 32-75 fathoms.

PANAMA: Bahia Honda; 30-50 fathoms, bottom sample 332.

COCOS ISLAND, COSTA RICA: Chatham Bay; 30-50 fathoms, bottom sample 329.

GULF OF CALIFORNIA: 12 stations; Outer Gorda Bank, north to Angel de la Guarda Island; 40-95 fathoms, rock, sand.

***Cyclopecten incongruus* (Dall) 1916**

Plate 13

Pseudamusium incongruum Dall, 1916, p. 403. *Albatross* station 2986, southwest of San Diego, in 684 fathoms. [Type labelled ". . . station 2986, N.W. of Cerros Id." Cerros Island now Cedros Island, Lower California.]

Pecten (Pseudamusium) incongruum Dall. Dall, 1921, p. 20.

Holotype: U. S. National Museum.

Type locality: *Albatross* station 2986, southwest of Cedros Island, Lower California, Mexico.

Original description: Shell small, white, suborbicular, left valve rather flat with short straight hinge line, ears concentrically scaly, sculpture of disk concentric continuous low sharp lamellae, crossed by slightly raised radial lines, conspicuous only at the intersections which form in the middle of the disk square reticulations with a small conspicuous pustule at each intersection; laterally these are more crowded; right valve concave near the margin, closely regularly concentrically lamellose; anterior ear with five radial lines, coarsely lamellose with a shallow notch and serrate margin. Height, 14; breadth, 15; diameter, 3 mm.

Remarks: This is the largest eastern Pacific *Cyclopecten*, none of the other species exceeding 10 mm in height. It is very distinct, and is known only from the type locality.

Cyclopecten barbarendis sp. nov.

Plate 14, figs. 1-2

Shell extremely small, quite thin, translucent, inequivalve and equilateral, largest specimen found (a left valve) measuring 4.5 mm in height; hinge line about $\frac{3}{4}$ as long as disk, with beaks protruding slightly above. Right valve shallowly convex and reflexed at ventral margin; disk covered with numerous very fine concentric ridges, stronger near ventral margin; 4-6 faint radial ridges adjoining anterior submargin. Anterior auricle longer than posterior and with 9 lamellose radial riblets; byssal notch rather shallow and no ctenolium present. Posterior auricle with 6 lamellose radial riblets. Left valve rather deeply convex; concentric sculpture consisting of 10 prominent rows of lamellae in juvenile stage, increasing to 18-20 later; radial sculpture of low narrow ridges, starting with 10-12 at the umbo and increasing by intercalation to 24-32 (of varying strength) at the ventral margin. Anterior auricle rather large and with shallow byssal sinus; rows of concentric lamellae present as on disk, starting with 8-10 in juvenile stage and increasing to 12-15; 7 or 8 fine radial ridges in juvenile stage, increasing to 10-12. Posterior auricle with 5-7 rows of concentric lamellae in juvenile stage, increasing to 8 or 9; 6 or 7 radial ridges, increasing to 8-10. External sculpture clearly visible from interior of valve.

Holotype: Juvenile specimen: height and length 3 mm; diameter 1 mm; hinge line 2.3 mm. Largest valve found (left): height and length 4 mm; diameter 1.5 mm; hinge line 3 mm. Allan Hancock Foundation.

Type locality: Off Santa Barbara Island, southern California, in 27 fathoms, Hancock expeditions bottom sample 1064; $33^{\circ} 30' 01''$ N; $119^{\circ} 02' 20''$ W; May 29, 1939.

This species also occurred in bottom sample 1086, taken off the east side of San Nicolas Island, southern California, in 30 fathoms; $33^{\circ} 18' 20''$ N; $119^{\circ} 28' 45''$ W.

Remarks: The sculpture of the left valve of this species separates it from any other eastern Pacific *Cyclopecten*. In fact, of all the species of this genus, the only one with similar concentric lamellae is the New Zealand *Cyclopecten aupouria* Powell (1937, p. 167, pl. 47, figs. 1-2). On the eastern Pacific *C. incongruus* (Dall) and the western Atlantic *C. reticulatus* (Dall) the lamellae are much less prominent. (The latter species was described by Dall (1886, p. 221, pl. 5, figs. 8, 10) as *Pecten* (*Pseudamusium*) *reticulatus*.)

At the author's request Dr. Harald A. Rehder, of the U. S. National Museum, compared individuals of this species with the holotype of Dall's *Pecten incongruum*; his comments follow: "The specimens from off Santa Barbara Island are not *P. incongruum* Dall, which is quite different, larger, flatter, and with the axial riblets not as strong, so that the sculpture is not as fenestrated as in your species. The concentric riblets of the latter are much more lamellate than in *incongruum*." Dall's species also differs from *Cyclopecten barbarensis* in being thicker and opaque, rather than thin and nearly translucent.

The recorded depths are quite shallow, but this species undoubtedly also lives in considerably deeper water.

Subgenus **DELECTOPECTEN** Stewart 1930

Delectopecten Stewart, 1930, p. 118. [Proposed as a subgenus of *Palliolum*.] Type species: *Pecten (Pseudamussium) vancouverensis* Whiteaves, 1893, p. 133, pl. 1, figs. 1-1a; type locality: Forward Inlet, Quatsino Sound, Vancouver Island, British Columbia, Canada, in ten to twenty fathoms, mud. [For geographical range see *Cyclopecten (Delectopecten) vancouverensis*, this paper. Whiteaves, Dall and several other authors invalidly emended *Pseudamussium* to *Pseudamussium*.]

Arctinula Thiele, 1934, p. 806. [Proposed as a section of *Palliolum*.] Type species: *Pecten Greenlandicus* Sowerby, 1842, p. 57, pl. 13, fig. 40; type locality: Greenland.

Catillopecten Iredale, 1939, p. 370. Type species: *Pecten murrayi* E. A. Smith, 1885, p. 303, pl. 22, figs. 1-1a; type locality: *Challenger* station 184, east of Cape York, Queensland, Australia, in 1400 fathoms.

Original diagnosis: In not having the posterior ear differentiated, *Delectopecten* includes a group of small forms now living in the N. E. Pacific which have been classed as "*Pseudamussium*" by Dall . . . , "*Pecten*" *murrayi* Smith from Australia . . . , and *Palliolum vitreum* . . . "*Pecten (Pseudamussium)*" *polyleptus* Dall, from the Galapagos Islands and "*P. (Pseudamussium)*" *panamensis* Dall also belong to this group [*panamensis* Dall, 1908; *panamensis* Dall, 1898 = *zaca* Hertlein, 1935.] *Palliolum vitreum*, which is from the North Atlantic, was apparently included in the original *Palliolum* Monterosato (1884, p. 5-6), but "*Pecten*" *incomparabilis* Risso, which has been designated as type species of *Palliolum* (Crosse, 1885, p. 140) seems to have a distinct posterior ear The type species of *Delectopecten* is "*Pecten*

(*Pseudamusium*)” *vancouverensis* Whiteaves, a living West Coast species Although the radial ribs predominate, the “*Camptonectes*-sculpture” is evident beneath them.

Additional diagnosis: Shells very thin, translucent and uncolored; without “ribs” (see below); left valve usually more convex than right; height and length identical or nearly so; valves identical in size except for *Cyclopecten greenlandicus*, in which right is smaller; disks occasionally having obscure and varying number of low concentric folds in umbonal region (in *Hyalopecten* folds are functional and more pronounced, occurring throughout disk). Posterior auricles poorly defined; in *Cyclopecten greenlandicus* their lateral margins are oblique, slanting from submargin to hinge line, in all other species margins are continuous with outlines of disks; ctenolium always present. Disks unsculptured only in *C. randolphi*, other species having either concentric rows of scales or vesicles, spinose radial ridges, or fine radial striae; right valve never concentrically lamellated or ridged as in *Cyclopecten*, although *C. vitreus* has unique form of minute ridges.

Remarks: *Delectopecten* differs from *Cyclopecten* s.l. in the shape of the auricles, the unflexed right valve (except in *Cyclopecten greenlandicus*), the absence of concentric lamellae or ridges on that valve (except in *C. vitreus*), the always-present ctenolium, and the translucency of all species.

The author cannot agree with Woodring (1938, p. 35), who assigned *Delectopecten* subgeneric rank under *Hyalopecten* Verrill (1897, p. 71). The latter was proposed as a genus, primarily because of the concentric undulations of the disks; while obviously separable from *Cyclopecten*, its other similarities make it more appropriately a subgenus under that unit.

Arctinula is synonymized here because the slight distinctions between its type and most species of *Delectopecten* are not felt to be of sufficient importance to warrant separation at more than specific level.

Since the type of *Catillopecten*, *Pecten murrayi*, was one of the species cited by Stewart, and since it agrees so well with the diagnosis of *Delectopecten*, Iredale’s genus is also synonymized.

In addition to the species cited above and others included in this paper, the following are also referable to *Delectopecten*: *abyssorum* Loven (north Atlantic to West Africa and probably Mediterranean); *parvulinus* Locard (Bay of Biscay); *translucens* and *micaceus* Dautzenberg & Bavay (Makassar Strait, Indonesia); *distinctus* E. A. Smith (Marion Island, Prince Edward Islands, South Indian Ocean).

KEY TO THE EASTERN PACIFIC SPECIES OF *Delectopecten*

1. Shell quite oblique; disks either smooth or with very fine (occasionally scaly) radial threads and minute concentric incremental lines; specimens higher than 10-14 mm, having ctenolium of minute beads *zaca* (Hertlein)
(Galapagos Islands; Gulf of Panama to northern Gulf of California)
1. Shell not oblique, or only very slightly; disks often obscurely undulated; ctenolium of 3-6 teeth
 2. Disks either smooth or with very minute radial striae . . .
. *randolphi* (Dall)
(Bering Sea to Guaymas, Mexico, in Gulf of California)
 2. Disks variously sculptured
 3. With spines or scales
 4. With spinose radial ridges and finer concentric ridges; interior of posterior auricle of right valve with angulate ridge *randolphi tillamookensis* (Arnold)
(Bering Sea to Cedros Island, Lower California)
 4. With 60 or more finely spinose radial ridges but no concentric ridges *vancouverensis* (Whiteaves)
(Bering Sea to southern end of Lower California; Gulf of California north to San Ildefonso Island)
 4. With about 36 radial rows of scales; fairly prominent low and smooth radial ridges covering disk
. *polyleptus* (Dall)
(Off southern Chile; Galapagos Islands)
 3. With concentric rows of vesicles, connected to each other by fine concentric ridges; also minute divergent radial striae *vitreus* (Gmelin)
(Strait of Magellan and off southern Chile; Clipperton Island; for complete range see species, this paper)

Cyclopecten (Delectopecten) vancouverensis (Whiteaves) 1893

Plate 15

[non] *Pecten caurinus* Gould. Dall, 1886, p. 216, pl. 5, fig. 4. "... young specimen . . . Sitka, Alaska." [= *vancouverensis* Whiteaves.]

[*non*] *Pecten Alaskensis* Dall. Whiteaves, 1887, p. 119. Forward Inlet, Quatsino Sound, Vancouver Island, British Columbia, Canada.
[= *vancouverensis* Whiteaves, *vide* Whiteaves, 1893, p. 134.]

Pecten (Pseudamusium) vancouverensis Whiteaves, 1893, p. 133, pl. 1, figs. 1, 1a. Forward Inlet, Quatsino Sound, Vancouver Island, Brit. Col., Canada.—Woodring, 1938, p. 37. "Apparently ranges from southern Alaska to San Diego in shallow to moderately deep water (12 to 200 fathoms)."

Pecten (Pseudamusium) alaskense Whiteaves. Dall, 1921, p. 20, pl. 1, figs. 4, 5. Bering Sea to San Diego, California.

Pecten (Pseudamussium) pedroanus (Trask) variety *vancouverensis* Whiteaves. Grant & Gale, 1931 [*ex parte*], p. 238. [*P. arces* Dall in synonymy; = *Cyclopecten (Delectopecten) randolphi tillamookensis* Arnold; see that species, this paper. Also incorrectly synonymized: *P. (Pseudamusium) vancouverensis fernandoensis* Hertlein, 1925b, p. 43, pl. 4, figs. 6, 7; a valid species.]

Pecten (Delectopecten) vancouverensis Whiteaves. Proc. Conch. Club So. Calif., 1944, no. 35, p. 14a. Bering Sea to San Diego, California.

Delectopecten vancouverensis Whiteaves. Morris, 1952, p. 16, pl. 4, fig. 1.

Holotype: ?

Type locality: Forward Inlet, Quatsino Sound, Vancouver Island, British Columbia, Canada, in 10-20 fathoms.

Original description: Shell small, equivalved, compressed lenticular, both valves being equally convex, ovately subcircular in outline apart from the ears and rather oblique; valves extremely thin and fragile, translucent and almost transparent, pale horn color with a slightly yellowish hue. Beaks placed a little behind the midlength; hinge line straight and very long; ears unequal in size, the posterior pair, which are much smaller than the anterior, alike, indistinctly defined and merging gradually and imperceptibly into the general convexity and marginal contour of that side of each valve; anterior ears large, subtriangular, prolonged laterally and longer than high, distinctly defined, that of the left valve somewhat convex in outline above and concave below, that of the right valve with a deep and acutely angular byssal sinus at its base.

Surface marked by densely crowded and exceedingly minute, irregular and rarely continuous, but on the whole radiating, simple or bifurcating raised lines, also by comparatively large, regularly disposed and distant squamose radii. In the center of each valve the minute and

non-squamose raised lines are essentially parallel to the larger squamose radii, but on the sides the former are disposed obliquely to the latter. The surface of the anterior ear of each valve is minutely cancellated with extremely minute raised lines, which are almost parallel to the hinge line, in addition to the coarser cross lines. The whole sculpture of the exterior of the test is far too minute to be clearly seen without the aid of a microscope or powerful simple lens, but under either of these a few faint concentric lines of growth are also visible.

Dimensions of the only specimen that the writer has seen: height, from beaks to base, 7.50 mm.; maximum length 7.75 mm.; greatest thickness through the closed valves, 2.25 mm.

Forward Inlet, Quatsino Sound, Vancouver Island, in ten to twenty fathoms mud, Dr. G. M. Dawson, 1885: one living specimen.

Additional descriptive notes: Although not mentioned in Whiteaves' very thorough description, a ctenolium of 3 to 6 teeth is present. Many specimens have shallow concentric undulations of the umbonal portion of the disk. On some specimens the squamose sculpture is almost absent and the radii more prominent. Very young shells are frequently nearly smooth. Whiteaves' phrase, "... pale horn color with a slightly yellowish hue." is misleading, for when specimens are washed they are devoid of color.

Remarks: The squarish angle of the posterior auricles and the longer hinge line distinguish this species from the related *Cyclopecten randolphi* and *C. randolphi tillamookensis*, the presence of sculpture on the disks also separating it from the former.

Geographic range: Bering Sea to southern end of Lower California, Mexico, and north in the Gulf of California to San Ildefonso Island, 26° 33' 30" N. Previous records indicated San Diego, California, to be the southern limit, but the species occurred at Hancock stations in Dewey Channel and off the San Benito Islands, western Lower California, and off San Ildefonso Island in the Gulf.

Geochronological range: Recent only.

Bathymetric range: 10 to 210 fathoms (rarely less than 50).

Ecological data: Usually on mud or sand bottoms, occasionally rock, shale or gravel; often attached to calcareous algae; often associated with brachiopods, crinoids, coralline or sponge.

Hancock Expeditions Collecting Stations:

WESTERN LOWER CALIFORNIA: 9 stations; 55-81 fathoms, gravel or sand.

SOUTHERN CALIFORNIA and SANTA BARBARA ISLANDS: 49 stations; 23-210 fathoms, rock, sand or mud.

Cyclopecten (Delectopecten) polyleptus (Dall) 1908

Plate 16, figs. 1-3

Pecten (Pseudamusium) polyleptus Dall, 1908, p. 403, pl. 10, fig. 9.*Holotype*: U.S. National Museum.*Type locality*: Albatross station 4642, four miles S, 41' E of Ripple Point, Hood Island, Galapagos Islands, in 300 fathoms, globigerina sand. [Dall gave the longitude as 41° E, obviously a mistake.]*Original description*: Shell small, thin, translucent white, compressed, having a marked "*Camptonectes*" striation, besides about thirty-six radial rows of minute, elevated, granule-like scales, very easily detached and more crowded near the middle of the base; hinge line straight; anterior ear in the right valve long, prominent, with five radial rows of scales and obvious concentric striation; byssal notch deep and wide, with a broad fasciole, the ctenolium with three free teeth; posterior ear not differentiated by a notch; profile of the valve, below and behind, a segment of a circle; interior with glassy polish, scar small and high up, hardly visible; margins entire; ligamentary pit small, shallow. Alt. of valve, 9.5; lon. of valve, 9.5; of hinge line, 6.5; diam. of right valve, 1.2 mm.

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Only the right valve was obtained at this station, but at station 2781, on the west coast of Patagonia, Southern Chile, in South Lat. 51° 52', in 348 fathoms, mud, . . . a left valve which probably belongs to the same species was dredged by the "Albatross" in 1888. The sculpture is essentially similar, except that the scales are fewer and more distant from each other; only 34 rows could be counted, and the umbonal part of the valve shows several concentric undulations. The ears are large, subequal, the anterior larger with six radial rows of scales. The "*Camptonectes*" sculpture is conspicuous upon the glassy shell.

Remarks: Although similar to *Cyclopecten vancouverensis*, this species differs greatly in sculpture. While *C. vancouverensis* has spinose radial ridges, *C. polyleptus* has radial rows of scales, the ridges on the former numbering twice as many as the rows of scales on the latter (often more); *C. vancouverensis* has very minute, irregular, discontinuous and rather divergent radial striae, *C. polyleptus* having fine but more prominent radial ridges, which are only slightly irregular and are continuous; the scales are also larger and more fluted in appearance on *C. polyleptus*.

This species is known only from the type locality, the other *Albatross* station (off southern Chile) mentioned by Dall, and station 2818, near the Galapagos Islands (in 392 fathoms).

Cyclopecten (Delectopecten) randolphi (Dall) 1897

Plate 16, figs. 4-5

Pecten Randolphi Dall, 1897, p. 86. Bering Sea to west Mexico, in 225 to 1005 fathoms.—Dall, 1902, p. 559, pl. 40, fig. 2.

Pecten (Pseudamusium) randolphi Dall. Arnold, 1906, p. 138, pl. 48, figs. 2, 2a. "The type . . . dredged . . . off Destruction Island, Washington, in 516 fathoms . . ."—Dall, 1921, p. 19. Bering Sea to Guaymas, Mexico.

Pecten Whiteavesi [Dall MS.]. Orcutt, 1915, p. 183. Off San Diego, California, in 413 fathoms.

Pecten (Pseudamusium) randolphi Dall. Oldroyd, 1924a [*ex parte*], p. 59, pl. 14, figs. 5, 6. [Figures = *Propeamusium (Parvamusium) davidsoni* (Dall).]

Pecten (Pseudamusium) pedroanus (Trask). Grant & Gale, 1931 [*ex parte*], p. 236. [*P. randolphi* Dall in synonymy. *P. randolphi tillamookensis* Arnold incorrectly synonymized.]

Pecten randolphi Dall. Woodring, 1938, p. 37. "Apparently ranges from Bering Sea to Cape Blanco, Oregon, in deep water (225 to 1064 fathoms)."

Pecten (Delectopecten) randolphi Dall. Proc. Conch. Club So. Calif., 1944, no. 35, p. 14.

Holotype: U. S. National Museum.

Type locality: Off Destruction Island, northwest Washington, in 516 fathoms.

Original description: Shell small, thin, glassy, unsculptured except by minute "camptonectes" striation which covers both valves, and more or less obscure concentric undulations which are most distinct on the right valve near the umbo, and in some specimens altogether absent; hinge straight and short, anterior ears distinct, posterior ears not defined by any fold or sinus, outline suborbicular, valves compressed, especially the right one; right anterior ear with six small imbricated radii above, below a wide, transversely striated fasciole derived from a well-marked byssal sinus; ctenolium with four or five functional spines. Length, 27.5; height, 26; diameter, 5 mm.

Remarks: This species differs from other eastern Pacific *Delectopectens* in the absence of any sculpture (except on the anterior auricle

of the right valve) and the wide angle formed by the lateral margins of the posterior auricles and the hinge line. Specimens from the Santa Barbara Islands and southward are usually more circular and of greater convexity. Very young specimens may be difficult to distinguish from *Cyclopecten vancouverensis* of similar size, but the latter are always sculptured to some degree.

The author examined a specimen in the Stanford University collection that Mrs. Oldroyd had labelled *Pecten whiteavesi*; it is identical with southern California specimens of *Cyclopecten randolphi*.

Geographical range: Bering Sea to Guaymas, Mexico (Gulf of California).

Geochronological range: Recent only.

Bathymetric range: 10 to 1064 fathoms.

Ecological data: Found on mud bottoms.

Cyclopecten (Delectopecten) randolphi tillamookensis

(Arnold) 1906

Plate 17

Pecten (Pseudamusium) randolphi Dall var. *tillamookensis* Arnold, 1906, p. 139, pl. 48, figs. 3, 3a. "From north of Unalaska, 351 fathoms, to off Tillamook Bay, Oregon, at United States Fish Commission Station 3346, at a depth of 786 fathoms."

Pecten (Pseudamusium) arces Dall, 1913, p. 592. "Off Santa Barbara, California, in over 500 fathoms, muddy bottom." [*Albatross* station 4425, in 1084-1100 fathoms.]

Pecten (Pseudamusium) tillamookense Arnold. Dall, 1921, p. 20. Pribiloff Islands, Bering Sea, to San Diego.

Pseudamusium arces Dall. Dall, 1925a, p. 24, pl. 27, fig. 4. Off Santa Cruz Island, California, in 534 fathoms.

[non] *Pecten (Pseudamussium) pedroanus* (Trask). Grant & Gale, 1931 [*ex parte*], p. 236. [*P. randolphi tillamookensis* Arnold in synonymy.]

[non] *Pecten (Pseudamussium) pedroanus* (Trask) variety *vancouverensis* Whiteaves. Grant & Gale, 1931 [*ex parte*], p. 238. [*P. arces* Dall in synonymy.]

Pecten (Pseudamusium) randolphi var. *tillamookensis* Arnold. Woodring, 1938, p. 37. "... Bering Sea to San Diego, generally in deep water (30 to 1084 fathoms)."

Pecten (Delectopecten) randolphi tillamookensis Arnold. Proc. Conch. Club So. Calif., 1944, no. 35, p. 14a.

Pecten (Delectopecten) arces Dall. Proc. Conch. Club So. Calif., 1944, no. 35, p. 14.—Hertlein & Strong, 1946, p. 61. "Off Santa Cruz Island, California, to Cedros Island, Lower California."

Pecten (Pseudamussium) tillamookensis Arnold. La Rocque, 1953 [*ex parte*], p. 35. "A synonym of *P. pedroanus* (Trask) according to Grant & Gale."

Holotype: U.S. National Museum.

Type locality: Off Tillamook Bay, Oregon; U.S. Fish Commission station 3346, in 786 fathoms.

Original description: Shell resembling *P. randolphi* in outline and general characteristics. Disk ornamented by numerous more or less prominent fine, radiating ridges, microscopic radiating striae, and incremental lines of varying prominence. The radiating ridges are narrow and thread-like, and appear to be more prominent anteriorly and near the lines of interrupted growth; the ribs are affected similarly to the disk by the interruptions in growth. The microscopic striae cover the whole surface of the disk and ribs and in a general way radiate from the umbo, but are seldom parallel to the ribs; on the portion of the disk and ear posterior to the umbo the striae are perpendicular to the lines of growth and are thus nearly parallel and not radiating. The right anterior ear has from 6 to 12 prominently imbricated radials.

Dimensions: Alt. 30 mm.; long. 30 mm.; hinge line 17 mm.; diameter 7 mm.

Additional description: Disk circular in some specimens, higher than long in others; left valve more convex than right. Small and narrow concentric undulations of disk often present either in umbonal region only or recurring nearly to ventral margin. Radial ridges of disk prominently spinose, continuing over both auricles of left valve and posterior of right; "incremental lines" actually low concentric ridges covering disk and less prominent than radials; on some specimens both radial and concentric ridges present only at margins. Anterior auricle of right valve with usually 5 to 7 but occasionally as many as 12 imbricated radii; wide fasciole, shallow byssal notch and ctenolium of 4 to 6 teeth. Interior surface of fold of posterior auricle of left valve angulate and ridged.

Remarks: The subspecies can be distinguished from the typical by the sculpture of the disk, the latter being totally unsculptured except for the anterior auricle of the right valve; the ridge inside of the posterior auricle of the left valve also separates the subspecies.

Geographical range: Bering Sea to Cedros Island, western Lower California, Mexico.

Geochronological range: Reported only from the Recent.

Bathymetric range: 30 to 1100 fathoms (rarely less than 300).

Ecological data: Usually found on mud bottoms, occasionally on and/or in sponge.

Hancock Expeditions Collecting Stations:

SOUTHERN CALIFORNIA and SANTA BARBARA ISLANDS:

9 stations; 420-950 fathoms, green or gray-green mud bottoms, associated with glass sponge and chaetopterids.

Cyclopecten (Delectopecten) vitreus (Gmelin) 1791

Plate 18

Pallium vitreum seu papyraceum Chemnitz [*ex parte*], 1784, p. 335, pl. 67, figs. 637a-c. [Chemnitz' specific names rejected by Internat. Comm. Zool. Nom., Opinion 184, 1944.] Fig. 637a: "Norwegen, Island und Grönland findet." [Figs. 637b-c: "aus Drontheim" (Trondheim, Norway) = *Pecten striatus* Müller, 1776, p. 248. "Island."]

Pallium vitreum Chemnitz. Schröter, 1788, p. 78. [Index of Chemnitz' names; rejected.]

Ostrea vitrea Gmelin, 1791, p. 3328. "Habitat in Oceano septentrionali."

Chlamys Papyracea Röding, 1798, p. 164.

Pecten vitreus Chemnitz. Bosc, 1824, p. 268. "Se trouve dans la mer du Nord."

Ostrea vitrea Chemnitz. Dillwyn, 1817, p. 263.

[non] *Pecten vitreus* Gray, 1824, p. 245. [= *P. Greenlandicus* Sowerby, 1842, p. 57, pl. 13, fig. 40. "... from Greenland."]

[?] *Pecten vitreus* Risso, 1826, p. 303, fig. 156. Mediterranean.

[non] *Pecten vitreus* King, 1831, p. 337. "Habitat in Fretto Magellanico (passim)." [= *P. natans* Philippi, 1845b, p. 57. "Patria: Fretum Magellanicum, Messier-Canal, Smith-Canal."]

Pecten vitreus (Pallium) Chemn. Philippi, 1844, p. 203, pl. 2, fig. 3.

Pecten Gemmellari Filii Biondi, 1859, p. 118, pl. 1, fig. 4.

Pecten (Chlamys) vitreus Chem. H. & A. Adams, 1858, p. 553.

Pecten vitreus Chemnitz. Jeffreys, 1879 [*ex parte*], p. 561. "Greenland, Iceland, Scandinavia, Shetland, S. W. France, coast of Portugal, Mediterranean, N. E. America, var. *abyssorum* "Challenger" Exp. (W. Patagonia); 20-600 fms." [*P. abyssorum* Loven in Sars, 1878, p. 22, pl. 2, figs. 6a-6c, a valid species; *Challenger* specimens all *vitreus*.]

- Pecten (Pseudamussium) vitreus* Chemnitz. Kobelt, 1881, p. 374.
- Palliolum vitreum* Chemnitz. Monterosato, 1884, p. 6.
- Pecten vitreus* (Chemnitz). E. A. Smith, 1885, p. 303. "Stations 307, 308, 310, 311, all off the west side of Southern Patagonia [Chile], in 140 to 400 fathoms; Station 232, South Japan, in 345 fathoms; and Stations 204, 207, and 209, all off the Philippine Islands, in 100 to 700 fathoms."
- Chlamys (Palliolum) vitrea* Chemnitz. Dautzenberg, 1889, p. 76. Azores.
- Pecten (Pseudamussium) vitreus* Gmelin. Dall, 1889, p. 34, pl. 64, fig. 141. Arctic to "Southern Patagonia"; also "off western Florida, in deep water."
- Pseudamussium gelatinosum* Mabille & Rochebrune, 1891, p. H-126. "Baie Orange." [Orange Bay, Beagle Channel, Tierra del Fuego.]
- Palliolum vitreum* (Chemnitz). Verrill, 1897, p. 66, pl. 18, figs. 6-13. "... off Nova Scotia and Newfoundland, in 57 to 400 fathoms, and extends southward in deep water down to 1537 fath., off Chesapeake Bay."
- Chlamys Chaperi* Dautzenberg & H. Fischer, 1897, p. 190, pl. 5, figs. 5-8. Azores.
- Chlamys (Pseudamussium) vitrea*, Chemnitz. Dautzenberg & H. Fischer, 1906, p. 69. Off Morocco, in 2165 metres; off Cape Verde Islands, in 1311 metres.
- Pecten (Pseudamussium) gelatinosus* Mabille & Rochebrune. Dall, 1908, p. 403. "Orange Harbor [Tierra del Fuego], Mabille; U.S.S. "Albatross," station 2785 [off southern Chile], in 449 fathoms, mud, temperature 47° F."
- Pecten (Cyclopecten) vitreus* (Chemnitz) Schröter. Dautzenberg & Bavay, 1912, p. 27. Previous records cited; also Siboga station 262: "Elat, côte Sud de l'île Grand-Kei, 27 m. profondeur, 1 exemplaire." [Grand-Kei (or Grand Kai) now Noehoetjoet Island, largest of the Kei (or Kai) Islands, Moluccas Group, Banda Sea, just west of New Guinea.]
- Pseudamussium (Palliolum) vitreum* (Gmelin). Kuroda, 1931, p. 81, figs. 94-95 (p. 97). Japan.—Hiro, 1938, p. 474, figs. 5a-5c. Japan.
- Chlamys (Cyclopecten) vitreus* (Chemnitz) Schröter. Bavay, 1936, p. 317.
- Chlamys (Cyclopecten) vitreus* (Chemnitz) Schröter var. *gelatinosa* Mabille & Rochebrune. Bavay, 1936, p. 317.
- Propeamussium (Cyclopecten) vitreum* (Gmelin). Carcelles, 1950, p. 76.

Propeamussium (Cyclopecten) vitreum gelatinosum (Mabille y Roche-brune). Carcelles, 1950, p. 76, pl. 4, fig. 73. "Región magallánica y Sur de Patagonia."

Palliorum [Palliolum] (Delectopecten) macrocheiricola Habe, 1951, p. 80. "New name for *Delectopecten vitrea* Hiro, 1938, Ann. Zool. Japon., vol. 17, p. 474 [actually given as *Pseudamussium (Palliolum) vitreum* (Gmelin) by Hiro], non Gmelin, 1791."

Delectopecten vitrea (Gmelin). Kuroda & Habe, 1952, p. 19. Pacific Ocean: -0° to 35° N; Japan Sea: to 46° N.

[non] *Delectopecten zacae* Hertlein. Hertlein & Emerson, 1953, p. 350, pl. 27, figs. 7, 10, 16. "... 110-200 fathoms off the east slope of Clipperton Island." [670 miles SW of Acapulco, Mexico. = *Pecten vitreus* Gmelin.]

Holotype: ?

Type locality: Unknown.

Original description (Gmelin): O. testa hyalina margine acuta: radii tenuissimis, squamularum arcubus concentricis.

Chemn. Conch. 7, t. 67, f. 637, a.

β) Chemn. Conch. 7, t. 67, f. 637, b, c.

Habitat in Oceano Septentrionali, inter fucos et zoophyta, lentis ut plurimum magnitudine, testa levi fragili alba. β) albo rubroque varia auricula altera emarginata spinosa.

Additional description: Shell small, averaging 20 mm in height and length, moderately to deeply convex and nearly transparent; hinge line $\frac{3}{4}$ to $\frac{5}{8}$ length of disk; anterior auricles slightly longer than posterior. Both valves ornamented with concentric rows of small vesicles, a minute ridge connecting them horizontally; rows of vesicles continue to hinge margin, covering posterior auricle of right valve and both auricles of left; when broken off, scales leave minute semicircular ridges, and these, together with connecting ridges, result in a continuous scalloped ridge. Anterior auricles of right valve with 5 to 8 concentrically lamellated radial riblets, a sharply angled, rather narrow byssal sinus, and a ctenolium of 3 to 6 teeth. Surface of both valves (except anterior auricle of right) covered with very minute and irregular radial striae.

Remarks: Despite its very wide distribution, this species is quite constant in form. Variable features are the distribution and profusion of the vesicles and the convexity of the valves, the latter often being also slightly oblique. Japanese specimens differ somewhat, being smaller, less convex, and less profusely ornamented, some also having low concentric undulations of the disk just below the umbo.

Regarding *Pseudamussium gelatinosum* Mabille & Rochebrune, Dall (1908, p. 404) said, "This is the species which by some authors has been referred to *P. vitreus* Gmelin, from which it differs by sparser distribution of the scales and of the rows of scales, and by a slight but obvious obliquity. The two forms are, however, extremely similar." For the following reasons the present author has synonymized *Pseudamussium gelatinosum* with *Cyclopecten vitreus*. First, nothing in its original description separates it from *C. vitreus*; second, Dall's criteria for separation are features fairly common to the typical; third, through the kindness of Dr. Harald A. Rehder, of the U.S. National Museum, the author's collection contains three specimens from the lot on which Dall based his opinion (*Albatross* station 2785, cited above), and they are identical with specimens in series of *C. vitreus* from various localities.

Geographical range: Eastern Atlantic: Iceland, western Norway, Shetland Islands, southwestern France, northern Spain, Portugal, Azores, Canary Islands, Cape Verde Islands, and off northwestern Africa. Mediterranean. Western Atlantic: Greenland to Chesapeake Bay; western Florida; Santa Cruz Territory, Argentina, to Strait of Magellan. Eastern Pacific: Strait of Magellan to 49° N (off southern Chile); Clipperton Island (670 miles SW of Acapulco, Mexico). Western Pacific: Moluccas; Philippine Islands; Japan (to 35° N).

This is the most widely distributed species of Pectinidae. Clipperton Island is added here, since the author determined specimens from there referred to *Cyclopecten zaca* Hertlein to be *C. vitreus*.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Recorded in 15 to 2327 fathoms.

Ecological data: From the little available, usually found on mud bottoms; often attached to gorgonians or hydroids; Japanese specimens frequently living on the giant crab, *Macrocheira kaempferi* De Haan.

Cyclopecten (Delectopecten) zaca (Hertlein) 1935

Plate 19

Pecten (Pseudamussium) panamensis Dall, 1908, p. 404, pl. 6, figs. 8, 10. "U.S.S. "Albatross," station 3354, Gulf of Panama, in 322 fathoms, mud, bottom temperature 56° F. . . . Also at stations 3389, 3396, 3407, and 3422, ranging from near Acapulco, Mexico, to the Galapagos Islands, in 141 to 885 fathoms, soft bottom, temperatures 37.2° to 53.5° F."

[*non*] *Pecten panamensis* Dall, 1898, p. 696. [= *Pseudamussium (Pecten) fasciculatum* (Hinds), 1845. See that species, this paper.]

Pecten (Delectopecten) zacae Hertlein, 1935, p. 321, pl. 18, figs. 3-6, 9-10. "... about 10 miles due east of San Jose del Cabo, [eastern] Lower California, in 20 to 220 fathoms, . . . ; . . . off Cape San Lucas, Lower California, in 20 to 25 fathoms."

Pseudamusium panamensis Dall. M. Smith, 1944, p. 52, fig. 687 [reproduction of original figures].

[non] *Delectopecten zacae* Hertlein. Hertlein & Emerson, 1953, p. 350, pl. 27, figs. 7, 10, 16. "110-200 fathoms off east slope of Clipperton Island." [670 miles SW of Acapulco, Mexico; = *Cyclopecten (Delectopecten) vitreus* (Gmelin).]

Holotype: U. S. National Museum.

Type locality: Albatross station 3354, Gulf of Panama, in 322 fathoms.

Original description: Shell translucent yellowish white, very thin, resembling mica in consistency, oblique, compressed; beaks small, low, polished, hardly projecting beyond the hinge line; ears small, subequal, the posterior feebly differentiated; the anterior right ear with a wide fasciole corresponding to the byssal sulcus, above which are five or more radial threads, the whole with strong incremental lines; on the lower margin of the fasciole is a line of minute beads, apparently a ctenolium which becomes obsolete at maturity; the other ears are sculptured like the rest of the disk; sculpture: on the left valve a feeble but distinct "*Camptonectes*" striation, rather coarse and irregular incremental lines, the whole crossed by 40-65 fine radial, sparsely, minutely scaly threads, the scales occurring usually at the intersection with a prominent incremental line; left [*lapsus calami*: right] valve with similar sculpture except that the "*Camptonectes*" striation is so fine as to require strong magnification and a good light to be seen at all; the valves are produced obliquely downward and backward; the surface sculpture yields readily to friction and many of the valves have lost it altogether, retaining only the concentric sculpture; left valve slightly more convex; interior glassy, the resiliary pit very small, the margins entire. Height, 18; length, 18; max. diam. 2.5; hinge line, 9.5 mm. A very large specimen is 22 mm. high.

Additional descriptive notes: Specimens from the Gulf of California are more convex, smoother and glossier than those from the Gulf of Panama, and often have a few very faint concentric undulations of the disks below the umbonal region. Dall was correct in surmising that the "minute beads on the lower margin of the fasciole" comprise a ctenolium in the juvenile stage; the teeth become bead-like after the shell reaches

an altitude of from 10 to 14 mm. The valves seldom have similar sculpture, usually only one having pronounced radial threads.

Remarks: Dall first used the name *Pecten panamensis* in 1898 (*loc. cit.*). In discussing the "section" *Pallium* he said, "*Pecten panamensis* Dall, which has in most respects an unusually close resemblance to *P. plica*, differs in having the cardinal laminae obsolete and in the presence of a byssal sinus and ctenolium." Discussing genera, he said, "Bucquoy, Dautzenberg, and Dollfus (1889) propose *Peplum*, with *P. clavatus* Poli as type, which would include such species as *P. panamensis*." No further description (in the accepted sense of the word) was given, nor was the species figured, but the features he mentioned in the first sentence, those he implied in the second, and the locality inferred by the name, add up to what may be construed as a "definition," in accordance with Article 25 of the International Rules; thus *Pecten panamensis* (1898) was established as a published name. Hinds, however, had described the same species in 1845 as *Pecten fasciculatus* (see *Pseudamussium* (*Peplum*) *fasciculatum* (Hinds), this paper); of that there can be no doubt, for no other species of *Peplum* is found in the eastern Pacific. Therefore, Dall's *Pecten panamensis* (1898) was a synonym for *P. fasciculatus* Hinds from the time it was published. Apparently forgetting that he had previously named the species, Dall described and figured it in 1908 as *Pecten* (*Pallium*) *miser*, thus adding another synonym for *P. fasciculatus*. In the same 1908 paper Dall described and figured *Pecten* (*Pseudamussium*) *panamensis*; since that name had been published earlier, *P. panamensis* (1908) was a homonym, and Hertlein rectified the matter in 1935 by re-naming the species *Pecten* (*Delectopecten*) *zacaе*.

Geographical range: Punta San Fermin, northern Gulf of California, to Panama Bay. Also Galapagos Islands. The author determined the Clipperton Islands specimens referred to this species to be *Cyclopecten* (*Delectopecten*) *vitreus* (Gmelin). The previously recorded northern limit for *C. zacaе* was San Jose del Cabo, eastern Lower California (Hertlein, 1935, p. 321), but in July, 1958, Dr. H. A. Rehder, of the U. S. National Museum, sent the author 139 lots of eastern Pacific material from the Museum collection for identification, and one lot contained a specimen from *Albatross* station 3035, off Punta San Fermin; that record extends the northern range by about 570 miles.

Geochronological range: Recorded only from the Recent.

Bathymetric range: Recorded in 5 to 1005 fathoms.

Ecological data: Found only on mud bottoms.

Hancock Expeditions Collecting Station:

GULF OF CALIFORNIA: 345 fathoms, mud; sta. 761-38 (south-west of Inner Gorda Bank).

Cyclopecten (Delectopecten) greenlandicus (Sowerby) 1842
(extra-limital)

Plate 20

Pecten vitreus Gray, 1824, p. 245.

[non] *Ostrea vitrea* Gmelin, 1791, p. 3328.

Pecten Greenlandicus Sowerby, 1842, p. 57, pl. 13, fig. 40. "... from Greenland." [Original spelling invalidly emended by subsequent authors.]

Pecten groenlandicus Sow. Loven, 1847, p. 186. "Finm." [Finmark County, Norway.]

Pecten Graenlandicus Sowerby. Hanley, 1856, p. 274. Greenland.

Pecten (Pseudamussium) grønländicus Sowerby. Mörch, 1857, p. 94.

Pecten grönlandicus Sowb. Mörch, 1868, p. 226. "6-7 miles north of Borgafjord; 85 fms."

Pecten groenlandicus Chemn. Whiteaves, 1872, p. 348. Off Anticosti Island, Canada (Gulf of St. Lawrence); 160-250 fathoms, mud.

Pecten groenlandicus, G. B. Sowerby. Jeffreys, 1879, p. 560. "Arctic Seas in the North Atlantic, from Smith Sound to Bergen and the Gulf of St. Lawrence, White Sea and coasts of Russian Lapland; 5½ to 1785 fms. Fossil: 82° 27' N. lat., Norway, Scotland, and Maine."

Pecten grønländicus Sow. Var. *major* Collin, 1887, p. 452. Kara Sea, Arctic Ocean.

Chalmys (Palliolum?) groenlandica (Sowerby). Dautzenberg, 1889, p. 76. Azores.

Camptonectes Groenlandica (Sow.) Verrill. Verrill, 1897, p. 82. Off Newfoundland, in 130-224 fathoms.—Verrill & Bush, 1898, p. 837, pl. 85, fig. 7.

Pecten Groenlandicus Sowerby. Locard, 1898, p. 399. Arctic region, Greenland, Russian Lapland, Lofoten Islands, Norway, Hebrides and Faeroe Islands, west and south of Ireland, Gulf of Gascony (Bay of Biscay), Gibraltar, Azores; western Atlantic to Gulf of St. Lawrence. "fossile dans les dépôts quaternaires de la Norvège, de l'Ecosse et du Maine."

Pecten (Palliolum) groenlandicus G. B. Sowerby. Chaster, Knight, Melvill & Hoyle, 1901, p. 12.

Pseudamusium andersoni Dall, 1919, p. 19a, pl. 2, figs. 7, 8. "Station 43a, Canadian Arctic Expedition, off Cockburn Point, Dolphin and Union Strait, Northwest Territories, Canada, in about 50 fathoms, gray mud and stones."

[non] *Pecten (Plagiectenium) andersoni* Arnold, 1906, p. 82, pl. 26, figs. 5, 5a, 6, 7, 8, 8a. Lower, middle, and probably upper Miocene of California; Miocene of Lower California.

Pecten (Pseudamusium) andersoni Dall. Dall, 1921, p. 20. Dolphin and Union Strait, Arctic Ocean.

Pecten binominatus Hanna, 1924, p. 175. "New name for *P. (Pseudamusium) andersoni* Dall, not *P. (Plagiopecten)* [sic] *andersoni* Arnold."—La Rocque, 1953, p. 34. "Known only from the type locality."

Palliolium groenlandicum (Sowerby). Soot-Ryen, 1932, p. 9. "Dall (1919) describes *Pseudamusium Andersoni* . . . nearly related to *P. groenlandicum* . . . perhaps only a variety . . . Not found [*groenlandicum*] in the Pacific, the Chukotsk and the Beaufort Sea. Occurring along the Eurasian shelf from 167° 30' E. and in the Atlantic south to off Sudan and to the Gulf of St. Lawrence. Also found to the north of America."

Palliolium (Arctinula) groenlandicum (Sowerby). Thiele, 1934, p. 806.

Pecten binominatus Hanna. Proc. Conch. Club So. Calif., 1944, no. 35, p. 14a. ". . . unfigured species with the position something of a mystery."

Holotype: ?

Type locality: Greenland.

Original description: T. aequivalvi, orbiculari, sub-compressa, sub-aequilaterali, pellucida, tenuissima, laevi; auriculis parvis, obtusangulatis, anticis minoribus; valva dextra lamina tenuissima, opaca, induta. Long. 1; lat. 0.25; alt. 1; poll.

Additional description: The shell is rounded, inequivalved, very thin, hyaline, nearly smooth, often with a violet iridescence when fresh. The left valve is covered, even from the nucleus, with fine microscopic camptonectes sculpture, in the form of thin, raised, divergent riblets, more or less irregular and wavy, most visible by translucency. The left valve sometimes has, also, fine radial striae and delicate lines of growth. The margins are thin and smooth, that of the right valve turns up a little against the other, which is larger, and the valves close very tightly, so that anteriorly there is scarcely any visible gape, even at the byssal notch or at the end of the auricle. The byssal notch is well-marked and

the pectinidial teeth are small and few. The byssus is probably very slender. The auricles are not oblique and are nearly equal. The hinge-plate is very thin; the single longitudinal ridge is scarcely visible.

A row of six or seven ocelli can be seen through the shell in alcoholic specimens. (Verrill & Bush, 1898.)

Remarks: Sowerby, in using the term "aequivalvi," was more nearly correct than Verrill, as quoted above, for the right valve is only occasionally larger than the left.

The author recently examined "co-types" of *Pseudamusium andersoni* Dall (= *Pecten binominatus* Hanna) and found that they are actually specimens of *Cyclopecten greenlandicus*. As can be seen from the range given below, *C. greenlandicus* is not an eastern Pacific species; under the names *Pseudamusium andersoni* or *Pecten binominatus*, however, it has appeared in works on the fauna of the region and therefore is included in this paper.

An author's original spelling must be preserved, unless a *lapsus calami* or misprint is evident, but from Sowerby's time to the present the only writers who followed his spelling were Forbes & Hanley (1853, p. 294).

Geographical range: Arctic Ocean, except Chuckchee (Chukotskoe) Sea (NW of Bering Sea). Eastern Atlantic: Iceland, west Norway, Faeroe Islands, Hebrides Islands, west and south Ireland, Bay of Biscay, Gibraltar, Azores and northwest Africa. Western Atlantic: Greenland to Gulf of St. Lawrence.

Geochronological range: Pleistocene, Recent.

Bathymetric range: Recorded in 5½ to 1785 fathoms.

Ecological data: Little available, but apparently always found in mud.

Subgenus **HYALOPecten** Verrill 1897

Hyalopecten Verrill, 1897, p. 71. [Proposed as a genus.] Type species: *Hyalopecten dilectus* Verrill & Bush in Verrill, 1897, p. 80; type locality: Albatross station 2570, off Martha's Vineyard, Massachusetts, in 1813 fathoms.—Verrill & Bush, 1898, p. 836, pl. 97, fig. 9. [Synonyms (*vide* North, 1951, p. 234): *Pecten fragilis* Jeffreys, 1879, p. 561, pl. 45, fig. 1; *non P. fragilis* Defrance, 1825, p. 251; *non P. fragilis* Jeffreys, 1876, p. 424 (= *P. biscayensis* Locard, 1888, p. 272). *Pecten undatus* Verrill & Smith, 1885, p. 444, pl. 44, fig. 21 (designated type species by Verrill, 1897, p. 71); *non P. undatus* Defrance, 1825, p. 257.]

Original diagnosis: Shell compressed, thin, hyaline. Valves nearly equal, with concentric undulations or corrugations, affecting the entire thickness; margins simple; sculpture none, or consisting of fine radial lines on one or both valves, without camptonectes sculpture. Hinge-plate thin and nearly plain; auricles well developed, unequal; byssal notch distinct.

Remarks: The regular concentric undulations of the disks are functional and always present, distinguishing *Hyalopecten* from any other supraspecific unit in the Pectinidae. In *Delectopecten* obscure and irregular concentric folds of the umbonal portion of the disk occur only occasionally, and are not functional.

The eastern Pacific *Pecten neoceanicus* Dall differs from Verrill's diagnosis in having the disks reticulately sculptured, an ornamental feature of only specific significance.

Only four known species are referable to *Hyalopecten*: the type species (*dilectus*), *biscayensis* Locard (Bay of Biscay), *neoceanicus* Dall, and *pubicus* E. A. Smith, the type locality of the latter being Marion Island, Prince Edward Islands, South Indian Ocean.

Cyclopecten (Hyalopecten) neoceanicus (Dall) 1908

Plate 2, fig. 2

Pecten (Pseudamusium) neoceanicus Dall, 1908, p. 402, pl. 9, fig. 4.

Holotype: U.S. National Museum.

Type locality: Albatross station 4721, SW of Galapagos Islands (8° 7' S, 104° 10' W), in 2084 fathoms, globigerina ooze.

Original description: Shell small, thin, brownish white, concentrically undulate and with both valves similarly reticulately sculptured, equi-valve, somewhat equilateral; beaks (showing small, polished prodisso-conch) small, pointed, the left one rising a little higher than the other; hinge line straight, ears subequal, sharply pointed, byssal notch and fasciole distinct, sculpture like that of the disk; surface of the valves with about four easy, wide, rounded undulations; surface sculptured with numerous fine, squarish, radial and concentric threads, subequal and subequally distributed, so that the meshes are mostly square, without nodulation at the intersections, and the interspaces are wider than the threads; disk short, kite-shaped, a little produced in front, suddenly constricted at the margin; interior white, polished, the umbonal cavities extending under the hinge line; the pit and resilium small. Alt. 12.0; lat. of shell, 12.0; of hinge line, 7.7; diam. 4.0 mm.

Remarks: This species is here referred to *Hyalopecten* because of the undulations of the disk (which are functional rather than the result of environment, as in some species of *Delectopecten*) and the small but well-developed auricles (similar to those of some specimens of the type-species). The reticulate sculpture of the disk distinguishes it from other species of the subgenus.

Geographical range: Reported only from the type locality and from U.S. Fish Commission station 3407, near the Galapagos Islands, in 885 fathoms.

Genus PSEUDAMUSSIUM H. & A. Adams 1858

Pseudamussium Herrmannsen, 1847, p. 340. [Invalid; no diagnosis or indication; no type species designated.]

Pseudamussium Mörch, 1853, p. 59. [Invalid publication (sales-catalogue); no type species designated; both species cited incorrectly synonymized. See *Remarks* below.]

Pseudamussium H. and A. Adams, 1858, p. 553. [Proposed as a subgenus of *Pecten*.] Type species: *Ostrea hybrida* Gmelin, 1791, p. 3318. [Gmelin's locality "in mari norwegico" in error; species based on *Pseud-amusium* of Lister, Klein and Chemnitz; Lister and Klein pre-Linnean and Chemnitz' figures erroneous; Chemnitz' specific names rejected; species living off west Africa. First valid designation of type by Dall, 1898, p. 751. Synonyms: *Pecten exoticus* Chemnitz, 1795, p. 262, tab. 207, figs. 2037, 2038; *Ostrea exotica* Dillwyn, 1817, p. 259; *Pecten dispar* Lamarck, 1819, p. 173; *Pecten Pseudamusium* (Klein) Sowerby, 1842, p. 56, pl. 19, figs. 211, 212, pl. 20, fig. 243; *Pecten orbicularis* Sowerby, 1842, p. 57, pl. 20, figs. 231, 232; *Pecten Loveni* Dunker, 1853, p. 44, pl. 9, fig. 31. For type localities, see *Remarks* below.]

Palliolium Monterosato, 1884, p. 5. [Proposed as a section of *Pecten*.] Type species: *Pecten incomparabilis* Risso, 1826, p. 302, pl. 11, fig. 154 [= *P. Testae* Bivona in Philippi, 1836, p. 81, pl. 5, fig. 17. Living in western Atlantic, from Norway to west Africa, and in Mediterranean.]

Original diagnosis: Shell fan-shaped, thin, sub-equivalve; valves longitudinally plicate, smooth or finely striated. (H. & A. Adams)

Additional diagnosis: Shell a little higher than long, thin but opaque and rather small, only unusually large specimens of *Pseudamussium hybridum* (Gmelin) or *P. tigerinum* (Müller) (1776, p. 248) attaining height of 25 to 28 mm. Valves moderately and nearly equally convex,

only *P. hybridum* having ventral margin of right valve flexed. Auricles varying from nearly equal to quite unequal, posterior being much smaller in *P. tigerinum*; byssal notch rather shallow to moderately deep. Right valve either smooth, having minute concentric growth lines or ridges, or with minute and obliquely divergent radial striae; *P. tigerinum* occasionally also radially corrugated or with fine radial ridges, minute radial striae always being present. Left valve with minute and obliquely divergent radial striae and often with fine radial ridges which may be minutely spinose; *P. tigerinum* occasionally also radially corrugated, always with minute radial striae.

Remarks: *Palliolum* was regarded as a synonym of *Pseudamussium* by North (see Preface). After studying many specimens of the west African *hybridum* (Gmelin) and the western Atlantic *incomparabilis* Risso, *tigerinum* (Müller) and *striatum* (Müller), the present author agrees, finding no basis for generic separation. Incidentally, *tigerinum* is an unusually variable species, for on the basis of structural variations certain specimens could be referred to either *Pseudamussium* s. s., *Pepulum*, *Aequipecten* or *Flexopecten*.

There has been considerable disagreement as to the first validation of this genus, the identity of its type species, and the valid name for the latter. North (1951, p. 231) discussed the problems, and in his unpublished Classification included a further discussion. The author is convinced that North, after exhaustive analysis, arrived at the only logical conclusions: the genus dates from the Adams,' the type species is the west African shell, and its valid name is *hybrida* Gmelin.

After studying all the original descriptions and figures cited by North, the author searched the literature for other references to the genus, designations of type, and various specific names involved in the case. The evidence indicated North's conclusions were correct.

A history of this unit and its type species follows, with comments on most of the references.

1. Lister (1685, tab. 173, fig. 10) gave this description of a shell: "*Pectenibus aequaliter auritis*, Laevibus. Pecten laevis, variegatus, admodum planus sive compressus." The figure was well-drawn, and easily recognizable as the west African shell. [Lister pre-Linnean and invalid.]
2. Klein (1753, p. 134, pl. 9, fig. 31) reproduced Lister's figure, named the shell *Pseud-amusium*, and gave a description based on Lister's. [Klein also pre-Linnean and invalid.]

3. Adanson (1757, p. 214, pl. 15, fig. 7) described a juvenile specimen of the same shell, naming it *l'Essan* and giving as the locality "... la côte du Sénégal." [Adanson pre-Linnean and invalid.]
4. Chemnitz (1784, p. 298, tab. 63, figs. 601, 602) referred to the descriptions and figures of Lister and Klein and adopted the name *Pseud-Amusium*. His own diagnosis of the shell, however, was based on the shell his figures represented, a European species which had been named and described eight years earlier: *Pecten septemradiatus* Müller (1776, p. 248). Therefore Chemnitz' own description and figures must be disregarded; having cited the earlier authors, he was obviously referring to their shell, and his assumption that it was identical with the European species does not alter that fact. Furthermore, the name *Pseud-amusium* is quite apropos when applied to the circular and smooth west African species, but not at all for the rather oblique and radially ribbed *P. septemradiatus*. [Chemnitz' specific names rejected by the International Commission on Zoological Nomenclature as being non-binomial.]
5. Gmelin (1791, p. 3318) cited the figures of Lister, Klein and Chemnitz, named the shell *Ostrea hybrida*, and gave as type locality "... in mari norwegico." Since that locality is correct only for *Pecten septemradiatus*, it indicates that he did not see the shell of Lister and Klein, but accepted Chemnitz' erroneous figures and description. Thus *Ostrea hybrida* was actually the first binomial name for the west African shell.
6. Chemnitz (1795, p. 262, tab. 207, figs. 2037, 2038) described and figured *Pecten exoticus*, which is identical with the shell of Lister and Klein, giving as locality (obviously incorrect), "Red Sea." Dillwyn (1817, p. 259) first validated the name *Ostrea exotica*.
7. Chemnitz (1795, p. 265, tab. 207, fig. 2043) described and figured *Pecten Danicus*. Since his erroneous 1784 description and figures for *Pseud-amusium* actually represented the common European shell we know to have been previously named *Pecten septemradiatus*, it is obvious that he considered *P. danicus* a distinct species. Several subsequent authors also did, others regarding it as a subspecies of *P. septemradiatus*. However, *P. danicus* is really in the synonymy of *P. septemradiatus*.
8. Lamarck (1819, pp. 177-178) invalidly restricted *Pecten hybridus* to the figures of Chemnitz cited by Gmelin, ignoring the fact that the latter had also cited those of Lister and Klein. As a variety Lamarck included the totally unrelated *Ostrea squamosa* Gmelin

- 1791, p. 3319). He also described *Pecten dispar* (p. 173), which is identical with the west African species.
9. Sowerby (1842, p. 56, pl. 19, figs. 211-212; pl. 20, fig. 243) realized the errors of Chemnitz, Gmelin and Lamarck. He referred a shell from Gambia (west Africa) to *Pecten Pseudamusium* Klein, thus first validating that name, and cited Klein's description and figure. As synonyms he listed "*P. exoticus*, Chem. . . . *P. dispar*? Lam. . . . *Ostrea hybrida*, Gmel. . . ." and said, "This is the true *P. Pseudamusium* of Klein, the *P. Pseudamusium* of Chemnitz being only a variety of his *P. Danicus*."
 10. Sowerby (1842, p. 57, pl. 20, figs. 231-232) described and figured *Pecten orbicularis* ("British Museum Co. of Africa."), actually a juvenile specimen of the same west African shell.
 11. Herrmannsen (1847, p. 340) listed *Pseudamussium* as a genus, first changing Klein's spelling. He did not validate it, however, for he gave no diagnosis or indication and did not designate a type species.
 12. Reeve (1852, sp. 13, pl. 3, fig. 13) synonymized under *Pecten Danicus* Chemnitz, "*Pecten pseudamusium*, Chemnitz (not of Klein)," and *Ostrea septemradiata* Gmelin (1791, p. 3327 = *septemradiatus* Müller, 1776). Under "*Pecten pseudamusium* Klein" (sp. 56, pl. 16, fig. 56), Reeve synonymized both *Pecten exoticus* Chemnitz and *Ostrea hybrida* Gmelin, indicating his realization that Chemnitz' *Pseud-amusium* had been erroneously described and figured, and Gmelin's *Ostrea hybrida* was identical with Klein's species.
 13. Mörch (1853, p. 59) proposed *Pseudamussium* as a genus and listed *Pecten glaber* Linné (1758, p. 698; *glabra*) and *P. septemradiatus* as species, but did not designate a type. He incorrectly synonymized *P. exoticus* Chemnitz under the totally unrelated *glaber* and "*P. pseudamussium* Ch." under *septemradiatus*, accepting Chemnitz' error in regard to the latter. [Mörch's work was merely a sales catalogue itemizing the contents of the Yoldi collection for prospective buyers, and therefore was not generally available. According to the definition of publication, as clarified by the International Commission on Zoological Nomenclature at its 1948 Paris meeting, the names in this catalogue are invalid.]
 14. Dunker (1853, p. 44, tab. 9, fig. 31) described and figured a very small shell, naming it *Pecten Loveni*. The locality given was "Guineam inferiorem" (Lower Guinea, at that time the name for the coastal area of west Africa extending from the present Camer-

- oun, formerly Cameroons, to Angola). Bavay (1936, p. 317) listed *Pseudamussium exoticum* Chemnitz, and in the synonymy included "*Loveni* Dunker (juv.)."
15. H. and A. Adams (1858, p. 553) first validated *Pseudamussium* as a supraspecific name, proposing the unit (as from Klein, with no mention of Chemnitz) as a subgenus of *Pecten*. Their list of species included both *hybridus* and *septemradiatus*, proving that they regarded them as distinct.
 16. Küster (1859, p. 86, pl. 19, figs. 7-8; pl. 22, figs. 5, 7, 10) included four species in the synonymy of *Pecten hybridus* Gmelin: Lister's shell, Chemnitz' *Pseud-amusium*, *Ostrea squamosa* Gmelin and *Pecten hybridus* Lamarck. He gave as locality the Philippines, which is correct only for *Ostrea squamosa*, and all five of his figures clearly represent that species.
 17. Chenu (1862, p. 184) dated *Pseudamussium* (as a subgenus) from Klein, listing "*P. pseudamussium* Lamarck," *P. glaber* Linné and *P. dispar* Lamarck as species. Klein was invalid, and the Adams' had validated the supraspecific name four years earlier; the specific names have been discussed.
 18. Stoliczka (1871, p. 426) dated *Pseudamussium* (as a subgenus) from Klein and designated *Pecten exoticus* Chemnitz as type. He was followed by Fischer (1886, p. 944), Philippi (1900, p. 108), Cossmann & Peyrot (1914, p. 106), von Teppner (1922, p. 208) and Marwick (1928, p. 456).
 19. Kobelt (1881, p. 373) and Zittel (1881, p. 29) designated *Pecten glaber* Linné as type species, following Mörch in erroneously regarding *P. exoticus* Chemnitz a synonym.
 20. Dall (1886, p. 219) dated *Pseudamusium* (as a section) from the Adams' (invalidly emending the name as they had proposed it), and designated, "types *Pecten dispar* and *P. pseudamussium* Lam."
 21. Verrill (1897, p. 60) and Arnold (1906, p. 50), adopting Dall's invalid emendation, also dated *Pseudamusium* from the Adams' (but as a subgenus), with *Pecten exoticus* as type.
 22. Dall (1898, p. 697) dated *Pseudamusium* (this time as a subgenus) from the Adams', designated *Pecten exoticus* as type, and placed in synonymy "*P. pseudamusium* (Klein) Sby."
 23. Dall (1898, p. 751) evidently reconsidered the matter of the type species and designated *Pecten hybridus* Gmelin; this was the first valid designation. He was followed by Suter (1913, p. 1880).

24. Woodring (1925, p. 72) and Cox (1948, p. 64) revived the correct spelling and dated *Pseudamussium* (as a subgenus) from the Adams,' with *Pecten hybridus* Gmelin as type.
25. Stewart (1930, p. 122) dated *Pseudamussium* from Mörch and said, "... *Pecten septemradiatus* Müller, is the type by absolute tautonymy since Mörch placed "P. pseudamussium Ch." in its synonymy; ..." In this instance "absolute tautonymy" is incorrect, for Mörch placed Chemnitz' species in the synonymy of Müller's only because he accepted Chemnitz' erroneous description and figures.
26. Grant and Gale (1931, p. 235) dated *Pseudamussium* (as a subgenus) from "Klein in Mörch," with *Pecten hybridus* Gmelin as type.
27. Thiele (1934, p. 807) and Rowland (1938a, p. 61) followed Stewart.
28. North (1951, p. 231) presented a thorough analysis of the problems, concluding that the genus dates from the Adams', the type species is *Ostrea hybrida* Gmelin, and Dall first validly designated the latter as type in 1898.

Summary: The central facts are these: the confusion as to the valid name for the west African shell was the result of Chemnitz' errors; the confusion as to the valid type species resulted from Mörch's acceptance of those errors and the addition of his own. Thus, apart from the status of Mörch's catalogue, on which the validity or invalidity of his proposal of the genus rests, Chemnitz' errors are seen to be the root of the matter. As a further result of those errors, if the International Commission on Zoological Nomenclature were to suspend the rules (as is permissible under the 1913 Monaco resolution) and accept the names in Mörch's catalogue, we could still not accept as type either of the two species he cited, and Dall's 1898 designation of *Pecten hybridus* Gmelin would remain the first valid designation. A brief recapitulation of the three problems follows:

A. The genus *Pseudamussium* must date from the Adams brothers. It cannot date from Klein, who was pre-Linnean, or from Herrmannsen, who gave no diagnosis or indication. Nor can it date from Mörch, whose sales catalogue was not a valid publication, according to the definition of that term as clarified by the International Commission on Zoological Nomenclature in 1948.

B. The valid name for the west African species is *Ostrea hybrida* Gmelin. Both Lister and Klein are invalid. Chemnitz, whose specific

names have been rejected, based his *Pseudamusium* on their descriptions and figures and was obviously referring to their west African shell, despite his errors in giving a description and figures of his own which actually represented the European *Pecten septemradiatus*. Gmelin cited the descriptions and figures of Lister and Klein and accepted those of Chemnitz, which were erroneous; the actual shell was still the west African one, however, therefore *Ostrea hybrida* Gmelin is its first binomial and first valid name. The following are synonyms: *Pecten exoticus* Chemnitz, *P. dispar* Lamarck, *P. pseudamusium* Sowerby, *P. orbicularis* Sowerby, *P. loveni* Dunker.

C. The type species is *Ostrea hybrida* Gmelin, first validly designated by Dall in 1898. Designations of other species were invalid, and resulted from the errors of Chemnitz, Lamarck and Mörch.

Subgenus **PEPLUM** Bucquoy, Dautzenberg & Dollfus 1889

Peplum Bucquoy, Dautzenberg & Dollfus, 1889, pp. 62, 67, pl. 16, figs. 10, 11. [Proposed as a subgenus of *Pecten*.] Type species: *Ostrea inflexa* Poli, 1795, p. 160, pl. 28, figs. 4, 5 [= *Ostrea clavata* Poli, 1795, p. 160, pl. 28, fig. 17, designated type by B., D. & D.]; type locality: Sicily.

Original diagnosis: Nous établissons cette section pour le *P. clavatus* qui, par sa forme générale, se rapproche de certains *Chlamys*; par la disposition de ses côtes rayonnantes, ressemble à certains *Aequipecten* (*flexuosus*), tandis que par la conformation de ses valves (valve droit bombée, valve gauche plane) il appartient plutôt au groupe des *Pecten* typiques. La très petite dimension des oreillettes est bien particulière.

Additional diagnosis: Shell of moderate size and either orbicular, obliquely orbicular or slightly higher than long; right valve more convex than left; ventral margins often flexed in type species and *fasciculatum* (Hinds), only rarely in *septemradiatum* (Müller); hinge line short ($\frac{1}{3}$ to $\frac{1}{2}$ length of disk). Ribs result of corrugations of disk and strength variable, ranging from shallow and gently sloping to deep and rounded; central ribs larger and becoming much wider toward ventral margin. Sculpture of disk in *inflexum* and *septemradiatum* consisting of very fine to fairly prominent radial ridges and/or very fine radial striae, stronger on left valve than on right; in *fasciculatum* of fine radial ridges and profuse concentric lamellae on both valves. Auricles quite small and anterior longer than posterior; riblets fine and sometimes imbricated. Byssal notch shallow; ctenolium absent in type species and adult specimens of

septemradiatum, present in *fasciculatum* and juvenile specimens of *septemradiatum*.

Remarks: Although Bucquoy, Dautzenberg & Dollfus designated *Ostrea clavata* as the type species and regarded *O. inflexa* as a synonym "or perhaps a variety," the latter has priority because its description precedes that of *O. clavata* on page 160 of Poli's work.

This subgenus is quite similar to *Flexopecten* in some respects, but can be easily distinguished by the shorter hinge line and correspondingly shorter auricles.

The presence or absence of flexed ventral margins in *P. inflexum* and *P. fasciculatum* is the result of individual variation, as can be seen by a long series of specimens from any one locality. In such genera as *Decadopecten*, *Flexopecten*, *Mesopectum* and *Semipallium* the same kind of variation within species is common.

Pecten septemradius Müller, here referred to *Peplum*, has been regarded as the type species of *Pseudamussium* by some authors; the matter has been discussed in this paper under that genus. Synonyms for *P. septemradius* are: *Ostrea pes-lutrae* Linné, 1771, p. 547 (comments on apparent priority below); *Pecten triradius* Müller, 1776, p. 248; *Pecten Pseud-amusium* Chemnitz, 1784, p. 298, tab. 63, figs. 601, 602; *Pecten Danicus* Chemnitz, 1795, p. 265, tab. 207, fig. 2043; *Pecten aspersus* Lamarck, 1819, p. 167; *Pecten Dumasii* Payraudeau, 1826, p. 75, pl. 2, figs. 6, 7; *Pecten nebulosus* Brown, 1835, p. 9, fig. 1; *Pecten Jamesoni* Forbes in Smith, 1839, p. 106, pl. 2, fig. 1. The apparent priority of *Ostrea pes-lutrae* Linné is not accepted here; it is quite certainly identical with *P. septemradius*, but the holotype (if any specimen was designated) is not known, the original description is as misleading as many others of Linné, and the figures of Gualtieri, Argenville and Lister that Linné cited are of little value. Dodge (1952, p. 196) has given an interesting and thorough discussion of the status of *pes-lutrae*, although the present author does not agree with his conclusion.

The most distinctive features of this subgenus are the plicate ribs which increase greatly in width toward the ventral margin and the very small auricles.

Peplum is represented by three living species: *inflexum* (Poli) in the Mediterranean, *septemradiatum* (Müller) in the eastern Atlantic, and *fasciculatum* (Hinds) in the eastern Pacific.

***Pseudamussium (Peplum) fasciculatum* (Hinds) 1845**

Plate 21

Pecten fasciculatus Hinds, 1845, p. 61, pl. 17, fig. 4. "West coast of Veragua [Panama]. In seventeen fathoms, among sandy mud."

Pecten panamensis Dall, 1898, p. 696. No locality given.

[non] *Pecten (Pseudamussium) panamensis* Dall, 1908, p. 404, pl. 6, figs. 8, 10. "... Gulf of Panama . . . Acapulco, Mexico, to the Galapagos Islands . . ." [= *Cyclopecten (Delectopecten) zacae* (Hertlein) ; see that species, this paper.]

Pecten (Pallium) miser Dall, 1908, p. 401, pl. 8, fig. 6. "U.S.S. *Albatross*, station 3355, Gulf of Panama, in 182 fathoms, mud, bottom temperature 54° .1 F."

Pecten (Decadopecten) fasciculatus Hinds. Hertlein, 1935, p. 318, pl. 18, figs. 1, 2. Panama.

Pecten (Mesopectum) fasciculatus Hinds. Hertlein & Strong, 1946, p. 59. Arena Bank, Gulf of California, to Panama.

Lyropecten (Peplum) fasciculatus (Hinds, 1845). Keen, 1958, p. 74, fig. 138.

Holotype: Previously reported at British Museum, but not traceable there at present (1958).

Type locality: West coast of Veragua, Panama, in 17 fathoms.

Original description: Testâ latè subtrigonâ, planiusculâ, tenui, inaequauriculatâ, rufo-violascente albo maculatâ; valvis consimilibus, costis parvis numerosis, eleganter serratis, in fascibus quinque plerumque aggregatis, alteris interstitiis suppletis; auriculis inaequalibus, rectis, argutè serratis, dentatis; intùs violascente.

Additional description: Shell rather small, maximum adult height about 32 mm; slightly higher than long, usually somewhat oblique and inequivalve, right valve exceeding left in convexity. Hinge line less than half length of disk. Auricles unequal, anterior being longer; byssal notch shallow and ctenolium of five teeth. Right valve moderately convex and with ventral margin usually flexed; left flatter and flexed less sharply or not at all. Ribs result of corrugations of disk; four in center of disk prominent, rounded and becoming much wider at ventral margin; a narrower and lower rib next to anterior margin and two next to posterior, with disposition occasionally reversed; small radial ridges and minute concentric lamellae covering disk. Anterior auricles with about five imbricated radial ridges; posterior with one to three fairly strong radial ridges adjoining hinge line, below them an excavated area having

smaller ridges and very fine concentric striae. Interior of each valve with about 28 radial ridges, smoothly angled in center of disk but sharply angled and more prominent near ventral margin. Exterior of each valve red-violet or purple-brown and with white markings; interior of right valve ranging from purple to peach, left valve violet.

Geographical range: Southern part of Gulf of California to Panama Bay.

Geochronological range: Reported only from the Recent.

Bathymetric range: Recorded in 17 to 182 fathoms.

Ecological data: Found in sand, muddy sand, mud or rock bottoms; associated with algae, coralline and coral.

Hancock Expeditions Collecting Station:

GULF OF CALIFORNIA: Outer Gorda Bank; 59-64 fathoms, coralline, sand; sta. 1034-40.

Genus **CHLAMYS** Röding 1798

Chlamys Röding, 1798, p. 161. Type species: *Pecten islandicus* Müller, 1776, p. 248 [designated type by Herrmannsen, 1846, p. 231], type locality: "I. Hörpudiskur . . . Island." Geographical range: see *Chlamys islandica*, this paper.

Zygochlamys von Ihering, 1907, p. 250. [Proposed as a subgenus of *Chlamys*.] Type species: *Pecten geminatus* Sowerby, 1846, p. 252, pl. 2, fig. 24; type locality: Patagonian formation (approximately Lower Miocene) of San Julian, Argentina.

Mimachlamys Iredale, 1929, pp. 162-163. Type species: *Pecten asperinus* Lamarck, 1819, p. 174; type locality: "Habite les mers australes, à la Nouvelle Hollande, les côtes de Diémen."

Scaechlamys Iredale, 1929, pp. 162-163. Type species: *Pecten lividus* Lamarck, 1819, p. 178; type locality: "Habite les mers de la Nouvelle Hollande, au port du Roi Georges."

Belchlamys Iredale, 1929, p. 164. [Proposed as a subgenus of *Scaechlamys*.] Type species: *Pecten aktinos* Petterd, 1886, p. 320; type locality: northwest coast of Tasmania.

Coralichlamys Iredale, 1939, p. 355. Type species: *Coralichlamys acroporicola* Iredale, 1939, p. 356, pl. 5, figs. 26, 26a [= *P. madreporarum* Petit in Sowerby, 1842, p. 68, pl. 14, fig. 68; type locality: Red Sea. Also found in the Indian Ocean, northern coast of Australia, northern Queensland, and East Indies northward to Japan.]

Original diagnosis: None given by Röding. First diagnosis of genus in restricted sense presented by Cossman & Peyrot, 1914, p. 110:

Forme en général ovale-oblongue; valves convexes, subégales; côtes radiales plus ou moins nombreuses, souvent squameuses; oreillettes inégales, surtout sur la valve droite dont l'oreillette antérieure, allongée, présente à sa base un sinus plus ou moins profond qui porte sur son bord inférieur une rangée de petites denticulations (filière, ctenolium, pectinidium, dents pectinidiales). Surface interne costulée, commissure des valves laciniée par les côtes.

Additional diagnosis: Shell moderately convex, left valve usually more so than right; a little higher than long and often oblique; ribs rather strong in most species, frequently increasing by bifurcation and occasionally fasciculated; riblets present in most species; ribs and riblets usually having spines or scales; anterior auricles larger than posterior; byssal notch moderate to large and ctenolium present.

Remarks: In a paper on the status of the Bolten catalogue, Dr. Harald A. Rehder (1945, p. 52) said, "It may be emphasized here again that the names proposed in this work should, according to the International Rules, be credited to Roeding, as Bolton [*sic*] furnished the names only, and not the 'name *and* (*italics mine*) its indication, definition or description' (last part of Article 21, International Rules of Zoological Nomenclature)."

Zygochlamys was based on a single feature: the fact that the ribs of the right and left valves differ in structure. That feature is possessed by so many species of Pectinidae that it cannot be regarded as a distinction of supraspecific value.

In *Mimachlamys*, as in so many other genera and subgenera proposed by Iredale, the diagnosis applies only to the type species. Despite that fact, he referred to the unit a number of species which do not agree with the diagnosis.

Scaechlamys and *Belchlamys* of Iredale were also based on features of only specific value.

Coralichlamys was proposed by Iredale with distortion as the only really distinctive diagnostic feature. Distortion is found in a number of completely unrelated species; furthermore the type species itself, *C. acroporicola* Iredale (actually *Pecten madreporarum* Petit in Sowerby), is quite inconstant in that respect.

KEY TO THE EASTERN PACIFIC SPECIES OF *Chlamys*

1. Shell rather thin and with spinose sculpture
2. Ribs wide, angular plications of disks and consisting of three spinose riblets

3. Adult shell 55 mm or higher; left valve with 9-10 primary and 10-11 secondary ribs, right valve with 9-10 pairs; interior predominantly white
4. Primary ribs of left valve with very long spines, secondary ribs very low and with very short spines; ribs of right valve with long spines on central riblet and much shorter ones on adjoining riblets
hastata (Sowerby)
 (Monterey to San Diego, California)
4. Primary ribs of left valve with moderately long spines, secondary ribs about half as high as primaries; ribs of right valve with moderately long spines on central riblet and shorter ones on adjoining riblets
hastata hericia (Gould)
 (Gulf of Alaska to Santa Barbara, California)
3. Adult shell less than 35 mm high; ribs of each valve nearly equal in size and spines quite short; fine punctate sculpture covering disks; posterior auricles obliquely truncated; interior nearly always red or red-orange
hastata pugetensis (Oldroyd)
 (Prince William Sound, Alaska, to Newport Bay, California)
2. Ribs narrow, rounded plications of disks; adult shell less than 24 mm high; ribs with central row of fine spines flanked by two low spinose riblets near ventral margin; interspaces with a low spinose riblet; internal surfaces of interspaces angulately ridged
lowei (Hertlein)
 (Galapagos Islands; Ecuador to northern Gulf of California; western Lower California north to San Benito Islands; Santa Catalina Island, California)
1. Shell thicker and without spinose sculpture
5. Right valve with 21-30 low, flat and dichotomous ribs
6. Left valve with interspaces concentrically ridged and with low central riblet; left valve white, with ribs brown or red; posterior auricles obliquely truncated
patagonica (King); ?*amandi* (Hertlein)
 (Puerto Montt, southern Chile, to Strait of Magellan; also in Atlantic, from Strait of Magellan north to Puerto Quequen, Chubut Territory, Argentina)
6. Left valve without concentric ridges but with fine reticulate sculpture; low riblet usually present in interspaces;

ribs fasciculate and imbricate sculpture present when not worn off; disk and ribs solid color or white, infrequently mottled *rubida* (Hinds)

(Bering Sea to Monterey, California; Japan)

6. Left valve (and right) with fine lattice-like sculpture over entire disk; ribs not fasciculate and imbricate sculpture weak; ribs of right valve dichotomous only near ventral margin; coloring nearly always mottled to some degree

. *rubida jordani* (Arnold)
(Gulf of Alaska to Puget Sound)

5. Right valve with 9-12 prominent ribs, either broad rounded fasciculi of 5-6 ridges, or narrower dichotomous and not fasciculate; color carmine or scarlet

. *islandica behringiana* (Middendorff)
(Bering Sea; Gulf of Alaska to British Columbia)

5. Right valve (and left) with over 50 low, narrow and profusely imbricated ribs of varying width

7. Disk occasionally with radial undulations (when present, rather slight); hinge line about $\frac{2}{3}$ length of disk; posterior auricles of moderate size

. *islandica* (Müller)
(Bering Sea and Aleutian Islands; for complete range see species, this paper)

7. Disk always with gently rounded undulations, wider on right valve than on left; hinge line about $\frac{1}{2}$ length of disk; posterior auricles very small

. *islandica albida* (Dall in Arnold)
(Bering Sea; Aleutian Islands to Japan)

***Chlamys islandica* (Müller) 1776 (extra-limital)**

Plate 22

Pecten islandicus Müller, 1776, p. 248. "I. Horpudiskur . . . Island."
—Chemnitz, 1784, p. 314, pl. 65, figs. 615, 616. [Chemnitz' specific names rejected by Internat. Comm. Zool. Nomen., Opinion 184, 1944.]

Ostrea cinnabarina Born, 1780, p. 103. "Patria ignota."

Pecten islandicus Müller. Fabricius, 1780, p. 415.

Pecten rubidus Martyn, 1784, pl. 153, fig. 1. "Foudland." [Newfoundland. Martyn's 1784 work rejected by Internat. Comm. Zool. Nomen., Opinion 456, 1957.]

- [*non*] *Pecten rubidus* Hinds, 1845, p. 61, pl. 17, fig. 5. [See *Chlamys rubida* (Hinds), this paper.]
- Ostrea Demissa* Solander, 1797, p. 52. Newfoundland. [Museum Calonnianum rejected by Internat. Comm. Zool. Nomen., Opinion 51, 1912.]
- Chlamys Cinnabarina* Born. Röding, 1798, p. 161.
- Chlamys Islandica* Müller. Röding, 1798, p. 161.
- Pecten Pealeii* Conrad, 1831, p. 12, pl. 2, fig. 2. "At the mouth of a river on the coast of Maine."
- Pecten icelandicus* Chemnitz. Sowerby, 1842, p. 75, pl. 17, figs. 159-161. "Northern Ocean."
- Pecten Fabricii* Ph. [Philippi], 1844, p. 101, pl. 1, fig. 5. "Patria: Groenlandia." [In index: "Halte ich jetzt für einen jungen *P. islandicus*." (I now consider it a young *P. islandicus*.)]
- Argus islandicus* Müller. Gray, 1851, p. 132. [*Argus* proposed as a genus by Poli, 1791 (intro. to vol. 1), p. 32. Invalid; preoccupied once in Gastropoda and twice in Lepidoptera; also proposed for, and based on characters of, animal only.]
- Pecten islandicus* Müller. Küster, 1859, p. 59, pl. 16, figs. 1, 2. Greenland, Iceland, Norway and North America.
- Pecten islandicus* Chemnitz. Küster, 1859, p. 105, pl. 30, figs. 1-6. Fig. 1: "Island."; figs. 2-6: "Neufundland."
- Chlamys Islandica* var. *insculpta* Verrill, 1897, p. 73, pl. 16, figs. 4, 5, 5a. "... on our northern coasts."
- Chlamys costellata* Verrill, 1897, p. 75. Off Newfoundland, in 67-72 fathoms.—Verrill & Bush, 1898, p. 835, pl. 86, fig. 6.—Dall, 1898, p. 735. "... very young specimen of the present species [*P. islandicus* Muller]."
- Pecten (Chlamys) islandicus* Müller. Dall, 1898, p. 735. "Pleistocene of New England and New Brunswick and northward on the boulder clays, also on the North Pacific coasts in deposits of the same age; living from the Arctic waters southward to Chesapeake Bay."—Arnold, 1906, p. 113, pl. 45, figs. 1, 1a. Living: North Atlantic; Bering Sea. Pleistocene: Dall's records. Pliocene (actually Pleistocene), Deadman Island, San Pedro, California.—Dall, 1921, p. 19. "Arctic Ocean to Kamchatka and Puget Sound. Also Atlantic."
- Chlamys islandica* Müller; var. *Fabricii* Philippi. Dautzenberg & Fischer, 1912, p. 323.

Pecten (Pecten) islandicus Müller. Grant & Gale, 1931, p. 161, pl. 11, figs. 1a, 1b. "Pliocene: Raised beaches at Nome, Alaska (Dall); uppermost Pliocene of Ventura County, California (Waterfall). Pleistocene: "Pliocene" of Deadman Island, San Pedro (Arnold); . . . Clyde beds of England (Wood) [1850, p. 40, pl. 5, fig. 1]." Living: Dall records cited; also "Scandinavia and North Scotland (Wood)."

Pecten (Chlamys) islandicus Müller. Proc. Conch. Club So. Calif., 1944, no. 35, p. 8. ". . . not of the Pacific coast fauna . . . never . . . south of the Bering Sea."

Holotype: Lost.

Type locality: Iceland.

Original description: Testa orbiculari aurita, circulis purpureis, radiis 100.

Additional description: Shell rather large, adult specimens averaging 80 mm in height and often reaching 100 or more; usually slightly higher than long. Convexity moderate and variable, with valves nearly equal. Hinge margin about half as long as disk. Both valves often having low radial folds of varying width. Number of ribs variable, usually from 60 to 100; ribs low, narrow, and of equal width or irregularly varying, with both bifurcation and intercalation usually present. Sculpture quite variable; whole surface of disk finely imbricated, or ribs imbricated and interspaces minutely reticulated. Anterior auricle of right valve well produced and imbricated, having 4 to 6 major riblets and varying number of smaller ones; byssal notch moderately pronounced and ctenolium having 4 to 6 teeth; posterior auricle much smaller, imbricated, with varying number of fine riblets and usually having vertical ridges of growth. Anterior auricle of left valve having moderate byssal sinus, imbricated, and with varying number of riblets; posterior auricle corresponding to that of right valve. Color range: brown-red, red, pink, red-orange, orange-yellow, yellow and white, often with concentric bands of lighter and darker shades.

Remarks: Although extra-limital, this species is included in the present paper because of the frequent references to it in literature on the eastern Pacific fauna south of the Bering Sea. Records from southern Alaska, British Columbia and Puget Sound were the result of misidentifications. *Chlamys islandica* varies considerably in number of ribs and in sculpture, but is quite distinct, and easily separable from its subspecies *albida* (Dall) and *behringiana* (Middendorff).

Geographical range: Arctic Ocean, except East Siberian and Leptev Seas; west coast of Norway; Iceland; Greenland; Hudson Bay; western Atlantic, from Arctic Ocean to Chesapeake Bay; Bering Sea and Aleutian Islands.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Low tide to 150 fathoms.

Ecological data: Usually found on rocky bottoms.

***Chlamys islandica albida* (Dall in Arnold) 1906**

Plate 23, fig. 1

Pecten (Chlamys) hericius var. *albidus* Dall (MS, 1904). Arnold, 1906, p. 136.

Pecten (Chlamys) hastatus var. *albidus* Dall. Arnold, 1906, p. 136, pl. 52, figs. 2, 2a. U.S. Fish Commission stations 3311, 3313, 3318 and 3321, Bering Sea, in 54-85 fathoms. [Type locality station 3313.]

Pecten (Chlamys) erythrocomatus Dall, 1907, p. 170. U.S.S. *Albatross* station 5021 [east coast of Sakhalin Island], in 73 fathoms.

Pecten (Chlamys) (hericius Gould, var.?) *albidus* Dall. Dall, 1921, p. 18. Aleutian Islands.

Pecten (Pecten) hastatus Sowerby variety *albidus* Dall in Arnold. Grant & Gale, 1931, p. 168. Bering Sea.

Chlamys (Chlamys) islandica erythrocomata (Dall). Habe, 1951, p. 73, text-figs. 140, 141.

Chlamys (Chlamys) hastata albida (Arnold). Habe, 1951, p. 73.

Chlamys hastata albida (Dall). Kuroda & Habe, 1952, p. 16. Pacific: 45° N-55° N.

Chlamys islandica erythrocomata (Dall). Kuroda & Habe, 1952, p. 16. Pacific: 51° N?; Japan Sea: 48° N and northward.

Pecten (Chlamys) albidus Dall. La Rocque, 1953, p. 31. Aleutian Islands.

Holotype: U.S. National Museum.

Type locality: U.S. Fish Commission station 3313, Iliuliuk Harbor, Unalaska, Aleutian Islands, Alaska.

Original description: Shell of the same shape and general appearance as *P. var. hericius*, but smaller when adult, being only about 45 millimeters in altitude. The sculpture on the right valve consists of numerous elevated, narrow, thread-like, imbricated riblets, which have the appearance of being grouped together in three or more unequal, equidistant, more or less convex fasciculi; the interspaces between the fasciculi are

ornamented by riblets of equal prominence to those forming the fasciculi; anterior ear with about seven equal, prominently imbricated radials; posterior ear short and with radial and imbricating sculpture; byssal notch quite prominent. Left valve similar to right, but with the fasciculi corresponding to the interspaces of the right valve, and consequently much narrower than the fasciculi of that valve. Color, white to very light pink.

Alt. 45 mm.; long. 40 mm.; hinge line 19 mm.; diameter 14 mm.

Remarks: The descriptions of *Pecten hastatus albidus* and *P. (Chlamys) erythrocomatus* are so similar that it would be impossible to definitely refer a specimen to either by relying on them. At the author's request Dr. Harald A. Rehder examined the holotypes of both and concluded "... I would be inclined to unite them."

Chlamys islandica albida is quite variable in form and sculpture. The disk may be longer than high or nearly circular, either flatly convex or rather deeply so; the ribs vary in number and may be well or poorly defined; the number of ribs varies; the imbricating sculpture varies in profusion and prominence.

The broad, low ribs and smaller auricles (particularly the posterior), are the chief differences between this subspecies and the typical. From *C. islandica behringiana* it differs in rib-structure and sculpture.

Geographical range: Bering Sea through the Aleutian Islands, Okhotsk Sea and Kurile Islands to Japan; Pacific coast of Japan as far south as 45° N, Japan Sea as far south as 48° N.

Geochronological range: Known only from the Recent.

Bathymetric range: 50 to 100 fathoms, possibly deeper.

Ecological data: None available.

***Chlamys islandica behringiana* (Middendorff) 1849**

Plate 23, fig. 2

Pecten Islandicus, var. *Behringiana* Middendorff, 1849, p. 528, pl. 13, figs. 1-3. "... im Behrings-Eismeere ..."

P. Hindsii var. *strategus* Dall, 1898, 704. [*Nomen nudum*; no "indication, definition or description."]

Pecten hericeus var. *strategus* Dall, 1898, p. 709. "Pleistocene of Alaska and recent at Unalashka."

Pecten (Chlamys) hericeus var. *strategus* Dall. Arnold, 1903, p. 110, pl. 11, fig. 5. Living: Unalaska. Pleistocene: Alaska; San Pedro.

Pecten (Chlamys) hastatus Sowerby var. *strategus* Dall. Arnold, 1906, p. 113, pl. 44, figs. 2, 2a, 3, 4. Living: Unalaska. Pleistocene:

Alaska; Deadman Island, San Pedro; Bath-house Beach, Santa Barbara. Pliocene: Packards Hill, Santa Barbara.

Pecten (Chlamys) islandicus beringianus Middendorff. Dall, 1921, p. 19. Bering Sea.—Oldroyd, 1924a, p. 55, pl. 41, figs. 1, 2.

Pecten (Pecten) beringianus Middendorff. Grant & Gale, 1931, p. 165, pl. 11, fig. 2.

Pecten (Chlamys) beringianus Middendorff. Proc. Conch. Club So. Calif., 1944, no. 35, p. 8. Bering Sea and Aleutian Islands.

Holotype: Akademiiâ nauk SSSR, Leningrad.

Type locality: Bering Sea.

Original description: Dem *Pect. Islandicus* höchst nahe, und wahrscheinlich nur eine *var. Behringiana* desselben. Leider besitze ich nur die Oberschale von dreier Exemplaren, welche im Behrings-Eismeere gesammelt worden; die grösste derselben ist 56 *m.* lang, um dabei 11 *m.* hoch, woraus ersichtlich wird, dass der Bauch dieser Oberschalen etwas gewölbter ist, als beim *Pect. Islandicus*. Die skulptur gleicht, nur stärker ausgeprägt, der Normalskulptur des *Pect. Islandicus*, und zwar wechselt je einer der 25 Hauptstreifen mit einem Zwischenstreifen, in einer Regelmässigkeit, wie das bei keinem der Exemplare jener Art der Fall war. Beiderlei Streifen sind übrigens ganz wie bei *Pect. Islandicus* geschuppt und auch die Zwischenräume lassen unter der Loupe jene raspelähnlichen Schüppchen sehen, welche Philippi abgebildet hat. Vielleicht hatte Hancock eine Uebergangsform zu dieser Skulptur vor Augen, als er schrieb (Ann. and Magaz. of Nat. Hist. Vol. XVIII, 1846, p. 332), dass die Exemplare der Davis-Strasse stärker gerippt seien, als die aus New-Foundland. Die Farbe ist innen weiss, mit Seidenglanz, und äusserlich karminroth, wie ich noch bei keinem *Pect. Islandicus* sahe, sondern übereinstimmend mit Hinds Abbildung, nur etwas minder violett.

Additional description: Adult shell averaging about 35 millimeters in altitude, slightly higher than long, inequivalve, equilateral, except for ears; both valves nearly flat up to an altitude of about 22 millimeters, where they generally become more convex by contraction, and the sculpture becomes more complicated. Right valve with 9 to 12 prominent, subequal, broad, nearly flat-topped, usually dichotomous, turgid ribs, with sometimes smaller intercalary riblets, all of which break up more or less suddenly into fasciculi of two or more riblets upon reaching an altitude of about 22 millimeters; interspaces subequal, broad and channeled; whole surface of disk and ribs microscopically tessellated; hinge line equal to about one-half length of disk; anterior ear much produced, and sculptured by fine imbricating incremental lines and about 6 radial

ridges; byssal notch prominent; posterior ear nearly obsolete, sculptured similarly to right [anterior]. Left valve resembling the right except that the ribs are narrower, more convex, and with the intercalary riblets usually more imbricated; interspaces broader than in right valve; anterior ear with about 8 imbricated ridges. Color of recent specimens bright scarlet. Alt. 35 mm.; long. 34 mm.; hinge line 17 mm., diameter 16 mm.; umbonal angle 83 mm. [83°]. This variety is easily distinguished by its few broad ribs, which increase in number very rapidly both by division and intercalation after reaching an altitude of about 20 millimeters. Arnold, 1906, describing *Pecten (Chlamys) hastatus* Sowerby var. *strategus* Dall.

Remarks: The Bering Sea, for which Middendorff named this subspecies, was originally the Behring Sea, after the Danish navigator Vitus Behring (1680-1741). Subsequent authors emended *Behringiana* to *beringiana* or *beringianus*, but Article 20 of the International Rules stipulates that original spellings must be preserved.

Dall (1914, p. 122) said, "*P. islandicus* Müller), extends from the Arctic south in constantly deeper water to the Strait of Fuca. Varieties of this were supposed to be *P. rubidus* Hinds by Middendorff, who did not know the true *rubidus* [Martyn, 1784; = *P. islandicus* Müller], and his name for one variety, *beringiana*, takes precedence of my variety *strategus*, which is identical."

As noted under *Chlamys islandica* (Müller), there are no valid records for that species from south of the Bering Sea.

The ribs of *Chlamys islandica behringiana* are quite variable. Those of the right valve may be low and broadly-rounded fasciculi of five or six ridges, or higher, narrower and dichotomous, dividing again near the ventral margin. On the left valve they may be broadly-rounded fasciculi with less prominent intercalaries, or narrow, distantly fasciculated and with more prominent intercalaries.

The differences in rib-structure and the smaller posterior auricles are the principle criteria for separating this subspecies from the typical.

Geographical range: Bering Sea; Gulf of Alaska, southward along the Alaskan coast and off British Columbia, Canada.

Geochronological range: Upper Pliocene, Pleistocene, Recent.

Bathymetric range: No data available.

Ecological data: None available.

Chlamys rubida (Hinds) 1845

Plate 24

- [*non*] *Pecten rubidus* Martyn, 1784, pl. 153, fig. 1. "Foudland."
[Newfoundland; = *P. islandicus* Müller, 1776. Martyn's 1784 work rejected by Internat. Comm. Zool. Nomen., Opinion 456, 1957.]
- Pecten rubidus* Hinds, 1845, p. 61, pl. 17, fig. 5. "Inhab. Alashka, Northwest America. At a depth of thirty-three fathoms."
- [*non*] *Pecten Fabricii*, Phil. Gould in Carpenter, 1864, p. 532. Carpenter: ". . . Dr. G.'s shells are the young of *P.* ('*rubidus*, ?var.') *Hindsii*." [*P. Fabricii* Philippi, 1845 = *P. islandicus* Müller, 1776. *P. Hindsii* a *nomen nudum*. Gould's shells from Puget Sound.]
- [*non*] *Pecten rubidus*, Hds. Middendorff in Carpenter, 1864, p. 534. Carpenter: "non Martyn, = *P. Islandicus*, Müll. Midd.'s pl. 13, f. 1-3 are marked in expl. of plates "*Islandicus*, var. *Behringiana*;" they are probably ("*rubidus*, ?var.') *Hindsii*. . . ." [Middendorff's figs. 1-3 really *P. Islandicus* var. *Behringiana* Middendorff. *P. Hindsii* a *nomen nudum*.]
- [*non*] *Pecten Fabricii*, Phil. Philippi in Carpenter, 1864, p. 574. Carpenter: " = *P. Islandicus*, jun. Non *P. Fabricii*, Gld., = *P. Hindsii*, jun." [*P. Hindsii* a *nomen nudum*.]
- "*Pecten rubidus*, Hds." Carpenter, 1864, p. 606. "Hinds's type in Br. Mus. appears the ordinary form, of which *P. hastatus* = *hericeus* is the highly sculptured var. This shell, which is more allied to *Islandicus*, may stand as *P. Hindsii*." [*P. Hindsii* a *nomen nudum*.]
- Pecten* (?var.) *Hindsii* Carpenter, 1864, p. 645. [First validation of name.] "Puget's Sound and the neighborhood." "Vancouver Island, Straits of S. Juan de Fuca, and adjoining shores of Washington Territory, formerly known as 'Oregon.'"
- Pecten hastatus* var. *Hindsii* Carpenter. Whiteaves, 1887, p. 119. Vancouver Island and adjacent localities.
- Pecten hericeus* var. *navarchus* Dall, 1898, p. 708. New name for *P. rubidus* Hinds, 1845, non *P. rubidus* Martyn, 1784. Boulder clay of Comox, Vancouver Island; also Pleistocene records from San Pedro and San Diego, California. Living: Aleutian Islands to Lower California.
- Pecten hericeus* var. *Hindsii* Carpenter. Dall, 1898, p. 709. Pleistocene of Sucia Island, Strait of Juan de Fuca. Recent from Bering Sea

to Monterey, California.—Palmer, 1958, p. 69. [Erroneous citation of *Pecten hericeus* var. *Hindsii* Carpenter as from Whiteaves, 1887, p. 119; as seen above, Whiteaves actually gave *Pecten hastatus* var. *Hindsii* Carpenter.]

Pecten (Chlamys) hastatus Sowerby var. *hindsii* Carpenter. Arnold, 1906, p. 111, pl. 43, figs. 1, 2, 2a. Previous Recent and Pleistocene records. "Pliocene [Pleistocene] Deadman Island, near San Pedro (Arnold)."

Pecten hastatus Sowerby var. *navarchus* Dall. Arnold, 1906, p. 112, pl. 43, figs. 1, 1a, 1b. Previous Recent and Pleistocene records; also "Pliocene" (Pleistocene) of Deadman Island and Timms Point, San Pedro. Middle Pliocene of Pacific Beach, San Diego.

[non] *Pecten rubidus* Chenu. Dautzenberg & Bavay, 1912, p. 3. [Bavay cited *Pecten rubidus* Chenu, 1843, as from "Chenu, Illustr. Conch., p. 3, pl. 7, figs. 1, 1a, 2, 2a (= *asper* Sow., non Lamarck)."] He was wrong about the specific name. On p. 3 (pt. 17, 1843) Chenu gave the new name *Pecten rubicundus* to *P. asper* Sowerby, 1842, because of the prior *P. asper* Lamarck, 1819, apparently unaware that Sowerby's species had been previously described as *tricarinatus* Anton, 1839; he figured *P. rubicundus* on pl. 7 (pt. 41, 1845), figs. 1, 1a, 2, 2a. In 1936 (p. 310) Bavay listed *Chlamys Hindsii* [sic] Carpenter, and gave as a synonym "= *rubida* Hinds (non Chenu)."]

[non] ?*Pecten (Chlamys) Hindsii* [sic] Carpenter. Dautzenberg & Bavay, 1912, p. 12. "Sailus ketjil îles Paternoster, 27 m. profondeur. 1 exemplaire très-jeune . . . Archipel. Sulu. 275 m. profondeur. 1 exemplaire jeune." [non *C. hindsii*; sp. ?]

Pecten (Chlamys) hindsii Carpenter. Dall, 1921, p. 18. Monterey to San Pedro, California.

Pecten (Chlamys) navarchus Dall. Dall, 1921, p. 18, Bering Sea to San Diego, California.

Pecten (Chlamys) washburnei venturaensis Waterfall, 1929, table opposite p. 78. "Upper Pico." [Upper Pliocene.]

Pecten (Chlamys) islandicus picoensis Waterfall, 1929, pp. 79, 83, pl. 5, figs. 2, 4. "Upper Pico and the San Pedro Pliocene." [Upper Pliocene.]

Pecten (Chlamys) venturaensis Waterfall, 1929, p. 84, pl. 6, fig. 4. "Type from top of Pico . . . Ventura County, California." [Upper Pliocene.]

Pecten (Pecten) islandicus Müller variety *hindsii* Carpenter. Grant & Gale, 1931, p. 163. Previous Pliocene, Pleistocene and Recent records.

Chlamys Hindsii [sic] Carpenter. Bavay, 1936, p. 310.

Pecten (Chlamys) hindsii hindsii Carpenter. Proc. Conch. Club So. Calif., 1944, no. 35, p. 6. "The source of the San Pedro and San Diego records . . . open to question."

Chlamys islandica hindsii [sic] (Carpenter). Kuroda & Habe, 1952, p. 16. Pacific: 42° N - 55° N. Kira, 1955, p. 49, pl. 49, fig. 9. Hokkaido, Japan; 100 fathoms.

Chlamys hindsii [sic] Dall ["Dall" *lapsus calami* for Carpenter]. Abbott, 1954, p. 365, pl. 34, fig. 1. "Alaska to off San Diego, California." ". . . dredged . . . down to 822 [typ. err?] fathoms."

Pecten (Chlamys) rubidus Hinds. Palmer, 1958, p. 69, pl. 3, figs. 4-6.

Holotype: ? No longer in British Museum.

Type locality: "Alashka."

Original description: Testâ subtrigono-orbiculari, inaequaliter duplo-convexâ, inaequauriculatâ subtenui; valvâ sinistrâ convexâ, costis parvis numerosissimis, serratis, in fasciculos duarum triumve alternatè aggregatis, rufis, interstitiis pallescentibus; valvâ dextrâ subconvexâ, albidâ, costis majusculis, aggregatis; auriculis sulcatis, posticâ parvâ, obliquâ; intûs, albâ.

Additional description: Adult specimens averaging 50 millimeters in height and slightly higher than long; left valve more convex than right, and hinge line about half length of disk. Right valve with extremely variable rib structure; 21 to 28 low, smooth, broad and rather flat primary ribs, becoming dichotomous at about 10 to 15 mm from hinge line and occasionally imbricated near ventral margin; ribs frequently narrower, obscurely fasciculated and almost entirely imbricated. Riblets often develop in interspaces, usually starting at 15 to 20 mm from hinge margin and occasionally imbricated. Interspaces narrower than ribs and with minute reticulations present in either upper or lower portion or throughout. Anterior auricle large and with 6 or 7 riblets having fine concentric imbrications; byssal notch prominent, and ctenolium of 5 to 7 teeth. Posterior auricle small, with 8 to 11 small spinose riblets; hinge margin tapering gently downward from beak. Left valve also variable in rib structure; primary ribs simple at first, later fasciculated; each fascicle consisting of three (occasionally two) imbricated ridges, often worn smooth at maturity; imbricated secondary rib usually present in center of each interspace, often flanked by two very small rows of spines. Interspaces wider than ribs and minutely reticulated from umbo to center of

disk. Anterior auricle large and with moderately deep byssal notch; 10 to 12 small riblets with nearly as many intercalaries, all imbricated. Posterior auricle small, hinge margin tapered as in right valve; 10 to 15 fine imbricated riblets. Interior glossy white or yellow-white; margin delicately fluted. External color ranging through shades of red, pink, lavender, purple, orange and yellow; right valve much paler than left; occasional specimens mottled, others all white.

Remarks: It is unfortunate that the specific name *hindsii*, by which this familiar species has been known for nearly a hundred years, must now become a synonym. However, in Opinion 456, 1957, the International Commission ruled that Martyn's often-disputed "Universal Conchologist" was not consistently binomial and rejected it, making all the names published therein unavailable; thus *rubidus* Hinds is now valid for this species, having priority over *hindsii* Carpenter.

Geographical range: Bering Sea to Monterey, California. Also Pacific coast of Japan, as far south as 42° N.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Just below low tide to 100 fathoms, possibly deeper.

Ecological data: Usually found off rocky shores. Shell usually encased in one of two species of symbiotic sponge: most often *Ectyodoryx* (formerly *Myxilla*) *parasitica* (Lambe), but occasionally *Mycale adherens* Lambe. Both species are said to live only on *Chlamys rubida*, *C. rubida jordani*, *C. hastata*, *C. hastata hericia* and *C. hastata pugetensis*, and to be the only species of sponge so restricted. Large barnacles, up to 25 or 30 mm in altitude, are often attached.

***Chlamys rubida jordani* (Arnold) 1903**

Plate 25

Pecten (Chlamys) jordani Arnold, 1903, p. 111, pl. 12, figs. 6, 7. "Rare in Pliocene [*emend.*: Pleistocene] of Deadman Island and lower San Pedro series of Deadman Island. Found also in Pliocene of Packard's Hill and Pleistocene of bath-house, Santa Barbara."

Pecten kincaidi Oldroyd, 1920, p. 135, pl. 4, figs. 3, 4. ". . . off San Juan Island, Washington, in 25 fathoms."

Pecten (Chlamys) hindsii kincaidi Oldroyd. Dall, 1921, p. 18. Puget Sound.—Oldroyd, 1924a, p. 53, pl. 12, figs. 1, 2. [Type locality given.]—Oldroyd, 1924b, p. 17, pl. 9, figs. 3, 4. [Type locality given.]

Pecten (Chlamys) jordani Arnold. Oldroyd, 1924a, p. 55, pl. 28, figs. 5, 6. "Puget Sound. In the Pliocene and Pleistocene of Santa Barbara, San Pedro, and San Diego."

Pecten (Pecten) islandicus Müller variety *jordani* Arnold. Grant & Gale, 1931, p. 164, pl. 11, fig. 4. "U. Pliocene: Santa Barbara (Arnold); upper Pico, Santa Barbara zone, Ventura Co. (Waterfall). Pleistocene: Type locality; also in the lower San Pedro series of the same locality (Arnold). Living: at various localities with *hindsii*, not the specimen figured by Oldroyd (see *Kincaidi*)."

Pecten (Pecten) islandicus Müller variety *kincaidi* Oldroyd. Grant & Gale, 1931, p. 164. "Living: In Puget Sound (and elsewhere with *hindsii*?)."

Pecten jordani Arnold. Eyerdam, 1938, p. 125. "Izhut Bay, Afognak Island, Alaska. Former range: Puget Sound and Strait of Georgia. Extended range: about 1200 miles northwestward."

Pecten (Chlamys) hindsii jordani Arnold. Proc. Conch. Club So. Calif., 1944, no. 35, p. 6. Pliocene of Deadman Island, San Pedro, Calif. . . . Forrester Island, and Howkan, Alaska, and in Puget Sound (Willett). [Eyerdam record also cited.]

Holotype: U.S. National Museum.

Type locality: Pleistocene of Deadman Island, San Pedro, California.

Original description: Shell of medium size, shape of *P. hericeus*, inequivalve, rather thin; right valve with twenty-five to thirty angular, smooth-topped, imbricated ribs, which become dichotomous after reaching a length of about 30 mm.; interspaces deeply channeled and narrower than ribs; anterior ear imperfectly radially ribbed with six ridges, and showing elevated, concentric, incremental lines; posterior ear nearly obsolete, showing four ribs; byssal notch not deep; left valve shows twenty-five to thirty narrow, convex ribs, showing imbrications only slightly; interspaces as wide as ribs; after a diameter [altitude] of 30 mm. has been reached by the shell, small riblets appear in the widening interspaces; anterior ear shows five narrow, imbricated ridges, with wide interspaces; both valves show a tendency to contract suddenly at the basal margin upon nearing completion of growth; surface of both valves covered with a minute, lattice-like sculpture, which is generally worn off on exposed portions of the shell. Dimensions.—Long. 42 mm.; alt. 45 mm.; diam. 15 mm.; hinge 18 mm.

Remarks: Arnold's criteria for *Pecten (Chlamys) jordani* are not all stable features; the ribs of the left valve are occasionally rather broad and flattened, the imbricating sculpture (but not the reticulating) is

often nearly absent, the basal margins seldom contracted or compressed.

Various criteria have been suggested for separating *Pecten hindsii kincaidi* from *P. hindsii jordani*, but a long series of specimens clearly shows the presence of only a single subspecies.

From *Chlamys rubida* this subspecies is distinguished by the following features: smaller size when adult, right valve not becoming dichotomous until shell attains height of about 30 mm, ribs of left valve smoother and not fasciculate, reticulate sculpture more prominent and covering entire surface of both valves, and coloring always mottled to some degree.

Geographical range: Gulf of Alaska to Puget Sound.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: 25 to 60 fathoms.

Ecological data: Found off rocky shores, often encased in same species of sponge as *Chlamys rubida*.

Chlamys patagonica (King) 1831

Plate 26

Pecten Patagonicus King, 1831, p. 337. "Habitat in Fretto Magellanico passim."—Sowerby, 1842, p. 54, pl. 13, fig. 60. "Patagonia and the Straits of Magalhaens."—von Martens, 1881, p. 79.—E. A. Smith, 1881, p. 44. "Stations [H.M.S. *Alert*] 1, 2, 3, 6 and Puerto Bueno, 2-7 fathoms, rocky bottom."

[? =] *Pecten australis* Philippi, 1845b, p. 56. "Patria: Insulae Chonos." [Chonos Islands, southern Chile. Von Martens (1881, p. 79) remarked that this species appears to have been based on juvenile specimens of *P. Patagonicus*. See *Chlamys amandi* (Hertlein), this paper.]

Pecten rufiradiatus Reeve, 1853, sp. 147, pl. 32, fig. 147. "Strait of Magalhaens."

Pecten patagonicus King. E. A. Smith, 1885, p. 294. "Juv. = *Pecten rufiradiatus* Reeve . . . ? = *Pecten australis* Philippi. . . Station 312, South Patagonia [Chile], in 9 fathoms; and Station 315, Falkland Islands, in 12 fathoms."—Dall, 1909, p. 256. "Magellanic Region, north to Chiloë Island and Puerto Montt [Chile]."—Carcelles, 1944, p. 275, pl. 9, fig. 73. Puerto Quequen [Chubut Territory, Argentina], . . . very rare . . . ; Santa Cruz [Territory, Argentina], Tierra del Fuego, "archipiélago magallánico, etc., . . ."—Carcelles, 1950, p. 77, pl. 4, fig. 72. "Patagonia hasta la Región magallánica, por el Pacífico hasta Puerto Montt, Chile, 10-150 metros."

Chlamys patagonica (King). Bavay, 1936, p. 307.

Holotype: ?

Type locality: Strait of Magellan.

Original description: P. testâ sub-aequivalvi, brunneâ, longitudinaliter creberrimè elevato-radiatâ; intus albidâ, longitudinaliter sub-radiatâ; long. $2\frac{4}{8}$; lat. $2\frac{4}{8}$; poll.

Obs. auribus inaequalibus.

Additional description: Shell averaging 55 mm in height and length; left valve moderately convex, right valve less; hinge line varying from slightly less than $\frac{1}{2}$ to slightly more than $\frac{2}{3}$ length of disk. Right valve having from 23 to 28 low, broad, rather flat and often dichotomous ribs, covered with fine concentric growth striae; ribs parallel to sub-margins smaller; interspaces narrower than ribs, concentrically lamellated and occasionally with low central riblets; anterior auricle of moderate length, with very fine concentric striae and 5 or 6 radiating riblets; byssal notch shallow and ctenolium of 4 to 6 teeth; posterior auricle about half as long and margin oblique, with fine concentric striae and 6 to 8 thin, oblique riblets. Left valve with higher and narrower rounded ribs, often flanked by secondary ribs near ventral margin; interspaces wider than ribs, having concentric ridges and a low central riblet; anterior auricle same length as that of right valve, with vertical margin, no byssal sinus, fine concentric striae and 7 or 8 small radiating riblets; posterior auricle same as that of right valve. Color range small: left valve white, with ribs and riblets of disk and auricles either brown, red-brown or red; right valve paler than left or uncolored, but often pale red on umbo.

Remarks: This species is similar to the North American *Chlamys rubida* in general appearance, but differs in length of hinge line, rib structure, sculpture and coloring.

Geographical range: Eastern Pacific from Puerto Montt, Chile, to Strait of Magellan; western Atlantic from Puerto Quequen, Chubut Territory, Argentina, to Strait of Magellan; Falkland Islands. A single juvenile right valve in the author's collection was found by a native on the beach at Anakena, Easter Island; it is quite worn, however, and cannot be accepted as conclusive evidence that *Chlamys patagonica* actually lives in that area.

Geochronological range: Bavay referred vaguely to fossil records, but the author could not locate confirming data. Available records indicate this is a Recent species.

Bathymetric range: 2 to 80 fathoms (from the few records available); probably somewhat deeper.

Ecological data: Recorded on rock, sand and mud bottoms.

***Chlamys amandi* (Hertlein) 1935**

(? = *Chlamys patagonicus* King, 1831)

Pecten australis Philippi, 1845b, p. 56. "Patria: Insulae Chonos."
[Chonos Islands, southern Chile.]

[non] *Pecten Australis* Sowerby, 1842, p. 76, pl. 19, figs. 210, 220.
"Swan River." [Western Australia, Australia.]

Pecten Australis Philippi. Von Martens, 1881, p. 79. "... appears ... to be the same as juvenile specimens of *P. Patagonicus* King ..."
[Translation from German. See *Remarks* below for status of *P. laetus*; *P. rufiradiatus* in synonymy of *Chlamys patagonica* (King), this paper.]

[? =] *Pecten patagonicus* King. E. A. Smith, 1885, p. 294. [In synonymy: "? = *Pecten australis* Philippi."]

Pecten rosaceus Stempell, 1899, p. 228. New name for *P. australis* Philippi, non *P. Australis* Sowerby. "Fundort: Calbuco [Chile]."
—Dall, 1909, p. 256. "Calbuco, Chiloë, and the Chonos Islands."

[non] *Pecten rosaceus* Deshayes, 1863, p. 31. [? *nomen nudum*; no description or figure located.]

[non] *Pecten varius* Linné var. *rosacea* Locard, 1888, p. 162.

[non] *Pecten distortus* da Costa var. *rosacea* Locard, 1888, p. 174.

[non] *Pecten tigerinus* Müller var. *rosacea* Locard, 1888, p. 245.

[non] *Pecten laevis* Pennant var. *rosacea* Locard, 1888, p. 248.

Pecten (Chlamys) amandi Hertlein, 1935, p. 305. New name for *P. australis* Philippi, non *P. Australis* Sowerby.

Holotype: ?

Type locality: Chonos Islands, southern Chile.

Original description: *P. testa* subaequivalvi, subaequilatera, ovata; radii 30-34 laevibus; interstitiis transverse lamellosis; valva superiore rubra, subunicolore; inferiore pallida; auriculis inaequalibus costatis. Alt. $10\frac{1}{4}$ ", diam. 9", crass. $3\frac{1}{3}$ ".

Translation: Shell inequivalve, inequilateral, ovate; 30 to 34 smooth ribs; interspaces transversely lamellated; upper (left) valve red, somewhat mottled; lower (right) valve pale; auricles unequal and ribbed. Alt. 20.5, long. 19, diam. 6.5 mm.

Remarks: Following the description Philippi said, "This species has almost entirely the same outline, number of ribs, and formation of

the ears, as *P. ornatus*, differing slightly, however, in the following characteristics; 1) the body of the shell is much more strongly arched, and describes more than a half-circle; 2) the ribs are all of equal size, not alternately smaller; 3) the latter are completely smooth, not scaled." (Translation from German.)

Stempell (*loc. cit.*) remarked of this species, "The largest, 60 millimetre examples of the Plate collection differ from the description of Philippi in that their ribs are not all the same size, and they evidence a scaly sculpture toward the shell's edge, but nevertheless they may with certainty be classified with the species described by Philippi, particularly since a small example from out of the Philippi lot exhibits uneven ribbing and, at least at the edge, weak traces of scales. The number of ribs varies also in the specimens present, just as in those of the Philippi types, between 30 and 34." (Translation from German.)

When von Martens mentioned *Pecten laetus* Gould he was undoubtedly referring to the shell Gould described under that name in 1850 (p. 345; New Zealand.); Gray had previously named the same shell *Pecten zelandiae* (Gray in Dieffenbach, 1843, p. 260; New Zealand.). Gould again used the name *Pecten laetus* for a different shell in 1862 (p. 39; Hakodadi Bay, Japan.); the second usage being invalid, Kuroda renamed the Japanese shell *Pecten (Chlamys) farreri nipponensis* (1932, p. 91), which Habe emended to *Pecten (Chlamys) nipponensis* (1951, p. 73).

Chlamys amandi and *C. patagonica* are almost certainly conspecific. However no figures of *C. amandi* were ever published and the author has not been able to locate any specimens identified as that species, so it does not seem advisable at present to place *amandi* in synonymy.

Chlamys hastata (Sowerby) 1842

Plates 27-28

Pecten hastatus Sowerby, 1842, p. 72, pl. 20, fig. 236. [No locality.] [?] *Pecten comatus* Valenciennes, 1846, pl. 18, fig. 2. [Carpenter (1864, p. 528) commented, "May be = *hastatus*, jun.; but, although figured without the red spot, it most resembles *Hin. giganteus*, jun."]] [non] *Pecten comatus* Münster in Goldfuss, 1833, p. 50, pl. 91, figs. 5a, 5b, 5c. "E montibus Westphalicis." [Jurassic of Westphalia, Germany.]

Pecten rastellinum Valenciennes, 1846, pl. 19, fig. 4. ["= *P. hastatus*, jun.", *vide* Carpenter, 1864, p. 528.]

Pecten denticulatus Adams & Reeve, 1848, p. 74, pl. 21, fig. 14. Borneo.
[= juvenile *P. hastatus* Sowerby, *vide* Bavay, 1905, p. 29.]

Pecten altiplicatus Conrad, 1857a, p. 191, pl. 3, fig. 2. Pliocene of the San Raphael Hills, Santa Barbara County, California.

Pecten altiplectus [typ. err. for *altiplicatus*] Conrad, 1857b, p. 313.
[*non*] *Pecten hastatus* Sowerby. Vaillant, 1865, p. 112. "désert de l'Attaka." [= *Chlamys squamosa* var. *decoriata* Jousseaume in Lamy, 1928 (p. 170. "Djibouti, Aden." Not figured.), *vide* Lamy, *loc. cit.* Latter species = *Pecten Ruschenbergeri* Tryon, 1870 (p. 171, pl. 14, fig. 1. "Bay of Muscat."), *vide* Eames & Cox, 1956, p. 13. "Muscat . . . Aden . . . Red Sea . . . M. Miocene, U. Miocene and Pliocene of Persia."]

Pecten hastatus Sowerby. Kobelt, 1888, p. 233, pl. 62, figs. 1, 2. "an der Nordwestküste Nordamerikas."

Pecten (Chlamys) hastatus Sowerby. Arnold, 1903, p. 109, pl. 11, figs. 4, 4a. Pliocene: San Pedro, Santa Barbara, San Diego (Arnold). Pleistocene: San Pedro, Santa Barbara (Arnold). Living: San Pedro (Oldroyd; Raymond).—Arnold, 1906, p. 108, pl. 41, fig. 4; pl. 42, figs. 1, 1a, 2, 2a. Living: Quatsino Sound, British Columbia, to San Diego. Also previous Pliocene and Pleistocene records.—Dall, 1921, p. 18. Monterey to San Pedro, California.

Pecten (Pecten) hastatus Sowerby. Grant & Gale, 1931 [*ex parte*], p. 166, pl. 11, figs. 6a, 6b. *P. hericius* Gould erroneously synonymized. Alaska to San Diego.

Chlamys hastata Sowerby. Bavay, 1936, p. 309. "= *denticulatus* Adams et Reeve (juv.)."

Chlamys hastatus hastatus (Sowerby). Abbott, 1954, p. 364, pl. 34, fig. j. Monterey to Newport Bay, California.

Holotype: British Museum.

Type locality: Here designated San Diego, California. (Probable source of Sowerby's specimens; many specimens from there examined by present author.)

Original description: T. ovali subtrigonâ, subelongatâ, scabrâ; auriculis inaequalibus, posticis minimis, anticis magnis, scabroso-sulcatis; valvâ sinistrâ, costis 8, inaequalibus, valdè elevatis, angulatis; spinas numerosas, erectas, subcrispatas ferentibus, costis interstitialibus numerosis, inaequalibus, serratis; valvâ dextrâ, costis 22, angulatis, spinosis; colore rubro, intus albo. Long. 0.95; lat. 0.30; alt. 1.15; poll.

Oval, inclining to triangular, rather elongated, rough; with very unequal ears, the posterior ones being very small; the upper valve has

eight unequal, elevated, angular ribs, with numerous erect, slightly curved, sharp spines, and several smaller spinose ribs in the interstices. The lower valve has 22 more nearly equal ribs with more numerous and smaller spines on the angles. The only specimen we have seen is in the collection of the Rev. F. J. Stainforth.

Additional description: Shell averaging about 64 millimeters in altitude, slightly shorter than high, inequivalve, equilateral (except for ears), compressed and with serrate margins; base evenly rounded below; sides slightly concave above. Right valve with 9 pairs of narrow, elevated, spiny ribs, along the sides of which are a pair of smaller spiny riblets; major interspaces much wider than ribs, concave-bottomed and ornamented by 1 or 3 thread-like, spiny, intercalary riblets; whole surface sculptured by microscopic imbricating lines, of which the spines on the ribs and riblets are only modifications; hinge line equal to one-half length of disk; ears unequal, the anterior being about two and one-half times the length of the posterior; anterior ear with 7 or 8 prominently spiny radials and minor riblets, and imbricating incremental lines; byssal notch deep and almost as wide as ear; posterior ear small, and sculptured by fine, spiny radials and imbricating incremental lines. Left valve with about 9 narrow, very prominently spiny ribs; interspaces wide, concave-bottomed, and ornamented by a single prominent, central, imbricated riblet, on each side of which are minor thread-like riblets; whole surface of disk with fine incremental sculpture as in right valve; ears similar to those of right valve except that the anterior has more ribs and riblets and no byssal notch. Hinge with almost obsolete cardinal crura. Color, golden yellow to pink, the left valve being the darker. (Arnold, 1906, p. 109.)

Additional descriptive notes: Juvenile specimens up to about 15 mm in height are more elongated. The color range includes various shades of red, pink, orange and yellow. The commensal gastropod *Capulus californicus* Dall is occasionally attached to the anterior side of the umbo of the right valve, as in *Pecten diegensis* Dall, and lives only on these two species, never alone or on any other mollusca.

Young specimens of 15 mm or less in height resemble the young of *Hinnites multirugosus* (Gale), but those of the latter can be distinguished by the following differences in structure: the disk equilateral (or nearly so), the ribs of the right valve divaricating, the posterior auricles larger and squared, the interspaces of both valves concentrically lamellose.

Remarks: Bavay's diagnosis of *Pecten denticulatus* Adams & Reeve (Borneo; Sulphur expedition) as a juvenile *Chlamys hastata* was un-

doubtedly correct. No species even remotely resembling the description and figure of *P. denticulatus* has been reported from the western Pacific; furthermore, while Adams and Reeve believed their species to have been collected during the voyage of the *Samarang* in that area, it has been established that Captain Belcher, who was on both the *Sulphur* and *Samarang* expeditions, mixed a number of shells from both.

Geographical range: Monterey, California, to San Diego, California.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Occasionally found in shallow water; usually in 10 to 50 fathoms.

Ecological data: Usually found on sand or shale bottoms, occasionally mud; often associated with coralline; frequently encased in sponge.

Hancock Expeditions Collecting Stations:

SOUTHERN CALIFORNIA and SANTA BARBARA ISLANDS:

26 stations; shore to 41 fathoms, rock, sand, mud.

***Chlamys hastata hericia* (Gould) 1850**

Plate 29

Pecten hericius Gould, 1850, p. 345. "Hab. Straits of de Fuca, Oregon" [Washington].

Pecten (Chlamys) hericeus Gould. Dall, 1898, p. 708. Pleistocene of San Diego, California. "? = *Pecten rastellinum* Val., Voy. *Venus*, pl. 19, fig. 4, 1835." [*lapsus calami*, 1846. *P. rastellinum* Valenciennes, 1846. = *P. hastatus* Sowerby, 1842.]—Arnold, 1903, p. 110. "Living: Straits of Fuca (Gould); ?Sitka to Santa Barbara (Cooper). Pleistocene: San Diego (Dall); ?Santa Barbara to San Diego (Cooper); San Pedro (Arnold). Pliocene: San Pedro (Arnold); ?Santa Barbara, San Fernando, San Diego well (Cooper); San Diego (Arnold)."

Pecten (Chlamys) hastatus Sowerby var. *hericius* Gould. Arnold, 1906, p. 110, pl. 43, figs. 3, 3a. "Living: Puget Sound (Dall, Carpenter, Button). Pleistocene (lower San Pedro formation): Deadman Island, San Pedro (Arnold). Pliocene: Temescal Canyon, Santa Monica Mountains, Los Angeles County (Rivers); Deadman Island, San Pedro (Voy, Arnold); Pacific Beach, San Diego (Hemphill, Arnold). Miocene (upper): San Lucas, Monterey County (Hamlin, Arnold)."

Pecten (Pecten) hastatus Sowerby. Grant & Gale, 1931 [*ex parte*], p. 166, pl. 11, figs. 6a, 6b. [*P. hericius* Gould in synonymy.] Living: Alaska to San Diego. [Upper Miocene, Pliocene and Pleistocene records also given.]

Chlamys hericus [*sic*] Gould. Morris, 1952, p. 17, pl. 12, fig. 2; pl. 41, fig. 2. Alaska to San Diego, California. [Specific name also misspelled on descriptions of plates.]

Chlamys hastatus hericius Gould. Abbott, 1954, p. 364, pl. 34, fig. k.
Holotype: U.S. National Museum.

Type locality: Juan de Fuca Strait, Washington. Gould's reference to Oregon was correct in 1850, for at that time Oregon comprised the present states of Oregon and Washington and part of British Columbia.

Original description: T. rotundato-triangularis, equilateralis, equivalvis; valvis convexus, sub-tumidis; valva superior rosea, lineis exilibus concentricis exasperata, et costis ad 24 angulatis, alternis majoribus et spinis erectis fornicatis insculpta; valva inferior pallidior colore saturatiori zonata, costis sub-equalibus spiniferis armata; natibus acutis, prominentibus; auribus obliquis valde inequalibus radiatim squamoso-striatis; intus porcellana; marginibus crenulatis, rosaceis. Long. $4\frac{1}{2}$; alt. $1\frac{1}{4}$; lat. $4\frac{3}{4}$ poll.

Additional description: Adult shell averaging about 70 millimeters in altitude, not quite as long as high, both valves compressed, equilateral (except for ears), which are decidedly unequal; margins finely serrate; sides markedly concave above; umbo acute. Right valve with 9 or 10 pairs of spiny fasciculi, the middle rib of each fascicule being the most prominent; interspaces about as wide as the fasciculi, and ornamented by several more or less spiny riblets; spaces between the riblets of the fasciculi and large interspaces channeled and ornamented by fine imbricating incremental lines, but free from any reticulations whatever; hinge line a little over one-half the length of the disk; anterior ear about two and one-half times longer than the posterior, ornamented by imbricating concentric lines, and above the notch by several subequal spiny riblets; byssal notch wide and deep; posterior ear small, and ornamented by numerous fine spiny riblets. Left valve with about 9 or 10 elevated fasciculi, the middle rib of each fascicule being quite prominently spinose; the spaces between the major fasciculi each occupied by a minor fascicule of more or less scaly riblets; interspaces between the riblets channeled and with imbricating incremental sculpture; ears sculptured as in right valve except that the riblets are smaller and more numerous on the anterior ear. Hinge weakly developed. Color pink to greenish [*sic*], left

valve the darker.

The only difference between *P. hastatus* and this variety is in the relative prominence and abundance of the ribs and riblets forming the fasciculi. In the right valve of the adult var. *hericius* each fasciculus consists of three nearly equal spiny riblets (the middle riblet of the three being slightly more prominent and spiny), between which and the middle riblet of the adjoining interspace are two small riblets (and sometimes another still smaller pair of intercalaries), while in the adult *P. hastatus* the fascicular arrangement on the right valve is obscure, there being a central spiny rib with 2 and sometimes 4 faint scaly riblets between the major rib and the middle riblet of the interspace. The fasciculi of the left valve of *P. hericius* are convex, and consist of a central more or less spiny rib, between which and the middle rib of the fasciculus of the interspace are about 9 to 12 thread-like scaly riblets; while in *P. hastatus* there is a high narrow rib with steeply sloping sides, having a top ornamented by numerous tall curved spines; between this rib and the rib running down the interspace are from three to five faint thread-like scaly riblets. (Arnold, 1906, *loc. cit.*)

Remarks: The main differences between this subspecies and the typical are the rib structure and the spinose ornamentation. On the left valve of the subspecies the secondary ribs are about half as high as the primary ribs and the latter have spines of only moderate length; on the typical the secondary ribs are extremely low and narrow, and the primary ribs have very long spines. (The primary ribs of the typical are not high and narrow, as Arnold said above, the very long spines only giving them that appearance.) On the right valve of the subspecies the central riblet of each fasciculus has spines of moderate length, which are not greatly longer than those of the adjoining riblets; on the typical the central riblet has spines which are very prominent and much longer than those of the adjoining riblets. The subspecies is seldom oblique, while the typical usually is.

Young specimens are separable from the young of *Hinnites multi-rugosus* (Gale) by their more elongate disks, shorter and more oblique posterior auricles, non-divaricating ribs of the right valve, and the absence of concentric lamellae in the interspaces.

The color range includes deep red to pink, pink-orange, orange, yellow, cream, and white. Radial bands of white or paler shades of the basic color are often present. From three to seven of the major ribs of the left valve are often very pale in color or white, a feature almost never seen in the typical.

Geographical range: Gulf of Alaska to Santa Barbara, California. (Records south of Santa Barbara doubtful.)

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Minus tide to 80 fathoms, possibly deeper.

Ecological range: Found on rock, shale, sand or mud bottoms. Shell usually encased in same species of symbiotic sponge as *Chlamys rubida*; barnacles frequently present on left valve, also of same species as found on *C. rubida*.

***Chlamys hastata pugetensis* (Oldroyd) 1920**

Plate 30

Pecten islandicus pugetensis Oldroyd, 1920, p. 136, pl. 4, figs. 5, 6.
" . . . off San Juan Island, Puget Sound."

Pecten (Chlamys) islandicus pugetensis Oldroyd. Dall, 1921, p. 19.
San Juan Island.—Oldroyd, 1924a, p. 55, pl. 12, figs. 4, 5. [Previous record cited.]

Pecten (Pecten) hastatus Sowerby variety *pugetensis* Oldroyd. Grant & Gale, 1931, p. 168. ?Middle Pliocene: southeast of Pico Canyon, Los Angeles County. Living: Puget Sound.

Pecten pugetensis Oldroyd. Gregg, 1938, p. 118. "Craig, Prince of Wales Island, Alaska, to Newport Bay, Orange County, California. I have fossil specimens, presumably Pliocene [Pleistocene], which were taken at Deadman Island, San Pedro, California."

Pecten islandicus pugetensis Oldroyd. Eyerdam, 1938, p. 125. "Hinchinbrook Island, Alaska (coll. Norberg). Former range: San Juan Island. Extended range: About 1000 miles northward."

Pecten (Chlamys) hericius pugetensis Oldroyd. Proc. Conch. Club So. California, 1944, no. 35, p. 5, figured on same page. Craig, Prince of Wales Island, Alaska, to Newport Bay, Calif. (Gregg).

Holotype: Stanford University.

Type locality: San Juan Island, San Juan Group, Puget Sound, Washington.

Original description: Shell much smaller than the typical *C. islandicus*. Sculpture coarser in proportion to the size. Shell more elongate and the ribs spinose. Ribs 17, with a very fine one in the interspaces. Length, 29; height, 31; diameter 11; hinge line, 16 mm.

Type locality off San Juan Island, Puget Sound. 12 specimens were obtained, two from the dredge, and ten from rocks on shore.

Additional description: Shell rather small, averaging 33 mm in height; higher than long and moderately convex, right valve more so

than left. Hinge $\frac{1}{2}$ to $\frac{2}{3}$ length of disk. Right valve with 17 to 21 rounded fasciculate ribs, often arranged in pairs; riblets of fasciculi minutely spinose when not worn smooth; interspaces as wide as ribs or wider, with small riblets irregularly disposed; fine punctate sculpture covering disk. Anterior auricle moderately long, with 5 or 6 imbricated riblets, wide fasciole, rounded byssal notch and ctenolium of 5 to 7 teeth; posterior auricle quite small, obliquely truncated, and with 7 or 8 oblique imbricated riblets. Left valve with fasciculated ribs more angulated and usually more profusely spinose; interspaces of varying width and with fine imbricated riblets irregularly disposed; punctate sculpture covering disk as in right valve; anterior auricle large, with shallow byssal sinus, 9 to 11 imbricated riblets, and with small intercalary riblets often present; posterior auricle same as that of right valve. Color range including brown, red-brown, red, pink, orange and yellow; interior of adult shells very glossy, with deep red-brown or red around ventral margin and often red-brown, red or red-orange above; juveniles having interior solid color, same as exterior.

Remarks: This subspecies is distinguishable from *Chlamys hastata* and *C. hastata hericia* by its rib-structure, sculpture of disk, obliquely truncated posterior auricles and internal coloring; juveniles 12 mm in height or less are only distinguishable by the punctate sculpture of the disk.

Geographical range: Hinchinbrook Island, Prince William Sound, Alaska, to Newport Bay, California.

Geochronological range: ?Pliocene; Pleistocene, Recent.

Bathymetric range: On rocks at minus tide, and in depths of to 40 fathoms.

Ecological data: Found on rocks at minus tide, and in rocky, sandy or muddy bottoms; often associated with algae; occasionally encased in same species of sponge as *Chlamys rubida* (Hinds).

Hancock Expeditions Collecting Stations:

SANTA BARBARA ISLANDS (southern California): 6 stations; 12-50 fathoms, sand, mud.

OREGON: on shale reef at -1.6' tide, sta. 1489-42.

***Chlamys lowei* (Hertlein) 1935**

Plate 31

Pecten (Chlamys) lowei Hertlein, 1935, p. 308, pl. 19, figs. 1, 2, 7, 8.

"Gulf of California; Galapagos Islands. ?Catalina Island, California."—Hertlein & Strong, 1946, p. 57. Carmen Island, Gulf

of California, and Clarion Island, to Panama and the Galapagos Islands. "?Santa Catalina Island, California."

Chlamys lowei (Hertlein, 1935). Keen, 1958, p. 72, fig. 133. "The Gulf of California to Panama, . . ."

Holotype: California Academy of Sciences, San Francisco.

Type locality: Carmen Island, Gulf of California, in 20 fathoms.

Original description: Shell moderately small, nearly equivalve, higher than long. Right valve with the exterior surface ornamented with 20 to 22 roundly triangular ribs; the ribs are crossed by strong imbricating lamellae which are fused to form a row of spinose nodes on top of each rib; toward the ventral margin traces of small riblets appear on each side of the major ribs about halfway between the tops of the ribs and the bottoms of the interspaces; interspaces narrower than the ribs and in each, a spinose riblet is present. Ears unequal, the anterior ear large, ornamented by about four to five riblets which are crossed by imbricating spines; a distinct byssal notch is present and a ctenolium consisting usually of four to five spines; posterior ear very small and ornamented by four to six spinose riblets. Left valve ornamented similarly to right; anterior ear with eight to ten spinose riblets, while on the posterior ear there are four to six riblets. The color in the living shells is generally gray toward the umbos flecked with brown spots, but grading to brown toward the ventral margin. Some specimens are reddish or orange brown. Type specimen, altitude 13.8 mm.; longitude 11.5 mm.; diameter of both valves 4.5 mm.

Additional descriptive notes: Further collections of this species have shown that the holotype was an adolescent shell. Hertlein remarked (1946, *loc. cit.*), "One of the largest specimens in the present collection measures approximately 18.5 mm. from beak to base." The present writer's collection contains a specimen from Clarion Island measuring 23.5 mm in altitude, probably the maximum size for the species, or very near.

Geographical range: Santa Catalina Island, California, to La Plata, Ecuador, including Guadalupe Island (180 miles west of central Lower California), and the Gulf of California. Also Galapagos Islands.

Hertlein's questioning references to Santa Catalina Island resulted from the occurrence of a left valve in 30 to 80 fathoms, Location 25610, California Academy of Sciences. A single valve cannot be accepted as definite proof of habitation, but at Hancock station 1155-40, off White Cove, Santa Catalina Island, a complete specimen and a right valve occurred among material dredged in 16 to 35 fathoms. In addition to

verifying the existence of *Chlamys lowei* off southern California, Hancock expeditions collections have extended the known range about 130 miles farther north in the Gulf of California (to San Felipe Bay), and about 500 miles farther south along the coast of South America (to La Plata, Ecuador).

Geochronological range: Known only from the Recent.

Bathymetric range: Recorded in 1 to 80 fathoms.

Ecological data: Found in rocky, sandy or muddy bottoms; associated with algae, kelp, bryozoa, coral, coralline and sponge.

Hancock Expeditions Collecting Stations:

GALAPAGOS ISLANDS: 13 stations; 12-80 fathoms, rock, sand, coral, coralline, bryozoa, nullipores.

ECUADOR: La Plata Island; 7-10 fathoms, rock, nullipores, sta. 213-34.

COLOMBIA: Cape Corrientes, 10 fathoms, mud, sta. 231-34; Port Utria, 20 fathoms, rock, sand, mud, sta. 423-35.

PANAMA: Medidor Island, 30-35 fathoms, coarse sand, mud, sta. 244-35; Secas Islands, "shallow water," coral, sta. 447-35.

CLARION ISLAND, REVILLA GIGEDO ISLANDS, MEXICO: Sulphur Bay; 57 fathoms, nullipores, sta. 137-34.

GULF OF CALIFORNIA: 15 stations; Cape San Lucas to San Felipe Bay; 1-75 fathoms, rock, sand, coral, coralline, sponge.

WESTERN LOWER CALIFORNIA: 1 mile south of San Benito Islands; 44-49 fathoms, sand, coralline, sta. 1250-41.

SANTA CATALINA ISLAND, CALIFORNIA: White Cove; 16-35 fathoms, mud, algae, kelp, sta. 1155-40.

Subgenus *ARGOPECTEN* Monterosato 1889

Argopecten Monterosato, 1889, p. 20. [Proposed as a subgenus of *Pecten*.] Type-species: *Pecten commutatus* Monterosato, 1875, p. 6. [non *Pecten solidulus* Reeve, 1853, sp. 155 (pl. 33, fig. 155), designated as type-species by Monterosato; see *Remarks* below. Synonyms for *P. commutatus* are: *Pecten Philippii* Recluz, 1853, p. 52, pl. 2, figs. 15, 16 (Sicily); non *Pecten Philippii* Michelotti, 1839, p. 11, no. 7 (Pliocene of Lombardo-Veneta, Italy); *Pecten atlanticus* E. A. Smith, 1890, p. 306, pl. 22, figs. 9, 9a, 9b (St. Helena Island). Geographical range of *commutatus*: western Atlantic, from Bay of Biscay to St. Helena Island; Mediterranean: Spain, France, western Sicily, Tunisia, Algeria, Spanish Morocco; ?Adriatic.]

Plagiectenium Dall, 1898, p. 696. [Proposed as a section of *Chlamys*.]

Type-species: *Pecten circularis* Sowerby, 1835, p. 110. "Hab. ad Sinum California (Guaymas)." [= *Pecten ventricosus* Sowerby, 1842, designated as type-species by Dall.]

Corymbichlamys Iredale, 1939, p. 367.

Type-species: *Chlamys corymbiatus* [sic] Hedley, 1909, p. 423, pl. 36, figs. 1-4. "... generally distributed in tropical Queensland."

Original diagnosis: Le nouveau vocable subgénérique *Argopecten* pourra s'appliquer aux espèces du grand groupe des *Pecten* ronds, épais, solides, quelquefois grands, équigibbeux, à côtes nombreuses et imbriquées et à coloration riche, pourprée, ornée de taches et de nuages violâtres. Les *P. pallium*, *gibbus* et bien d'autres espèces vivantes exotiques, comme aussi les *P. dubius*, *scabrellus* fossiles, etc. rentrent dans ce groupe.

Translation: The new subgeneric name *Argopecten* is applied to species of a large group of Pectens which are round, stout, solid, sometimes large, equigibbous, the ribs numerous and imbricated and the coloration rich, purple, ornamented with spots and clouds of violet. *P. pallium*, *gibbus*, and other living exotic species, also fossils like *P. dubius*, *scabrellus*, etc., belong to this group.

Additional diagnosis: Shell moderately to deeply convex, right valve more so than left in most species; usually rather thick; type-species and several others obliquely orbicular, remaining species orbicular or nearly so; ribs strong, and in some species radially ridged; concentric lamellae present between ribs of most species, occasionally crossing ribs, and often quite profuse; all species but *irradians* Lamarck and *purpuratus* Lamarck with well-developed hinge armature, cardinal (or linear) crura and provinculum being prominent, crura often so strong as to lock valves tightly.

Remarks: As type-species of *Argopecten* Monterosato selected *Pecten solidulus* Reeve (1853, sp. 155; "Hab.—?"), citing *P. Philippii* Recluz as a synonym and remarking that the synonymy was "probably contestable." It is certainly contestable. First, *solidulus* is not identical with *Philippii* Recluz, as will be shown below; second, it is peculiar that he cited *Philippii* Recluz in 1889, for in 1875 he had renamed that species *commutatus* because of Michelotti's prior usage of *Philippii*. His synonymy was also regarded as erroneous by Dautzenberg & Fischer (1906, p. 59) and Gignoux (1913, p. 370).

The shell Reeve described as *solidulus* was from an unknown locality; also it was a juvenile, as were the holotypes of a number of his

other species. After describing it he remarked, "This has the appearance of a young *P. gibbosus* [*lapsus calami* for *gibbus*], but it is distinct." F. K. North examined the holotypes of *solidulus* and *Philippii* in the British Museum and told the author that he found them to be quite distinct, a particularly noticeable difference being that the auricles of *solidulus* are proportionately about three times the size of those of *Philippii*. In the literature of the 18th and 19th centuries drawings were usually stylized to the detriment of scientific accuracy. Since no additional specimens referable to *P. solidulus* have ever been reported, it is quite probable that the original was a specimen of some previously described species. Judging from Reeve's figure, the shell might be a juvenile *Ostrea gibba* Linné (1758, p. 698), *Ostrea flabellum* Gmelin (1791, p. 3321), *Pecten circularis* Sowerby, or even *P. purpuratus* Lamarck.

It is more than likely that Monterosato never saw the holotype of *P. solidulus*, but since he was obviously familiar with *P. commutatus* (= *P. Philippii* Recluz), it would seem safe to assume that he based *Argopecten* on the characters of that species and intended it to be the type-species, erroneously regarding it as identical with (and a synonym of) the earlier *solidulus*.

While we can realize from the type-species Monterosato's intention in erecting *Argopecten*, his diagnosis is inapplicable in two respects, and he was, of course, mistaken in referring "*P. pallium*" to his new subgenus. The ribs in *Argopecten* seldom have imbricating sculpture, and any restriction as to coloration is unrealistic in a subgenus comprising a number of species and subspecies. "*P. pallium*" (*Ostrea pallium* Linné, 1758, p. 697) is obviously generically distinct from *P. commutatus*, and was so well known even in Monterosato's time that only carelessness would seem to account for his mention of it.

Aequipecten was proposed by Fischer (1886, p. 844) with a very brief diagnosis: "Forme circulaire; côtes rayonnantes bien marquées." Here again we can realize the author's intention by the type-species he designated, in this case *Ostrea opercularis* Linné (1758, p. 698). Although various authors have referred to *Aequipecten* such species as *Ostrea gibba* Linné, *Pecten irradians* Lamarck (1819, p. 143) and *P. circularis* Sowerby, it is obvious that they can not be cogenetic with *O. opercularis*. *Argopecten* differs from *Aequipecten* in the following respects: the convexity of both valves is greater, the right shell is thicker, ribs stronger, hinge armature almost always more pronounced, concentric (rather than radial) lamellae often present, and a tendency toward obliquity is quite common.

Plagiectenium was proposed by Dall to separate from *Aequipecten* those species which conform to his diagnosis, but he was apparently unaware that Monterosato had created a supraspecific unit for them nine years earlier.

Corymbichlamys Iredale (another of his monospecific genera) was based on the lattice-like ornament between the ribs and the lamellae and small nodules on the ribs of the type-species. In all other respects that species is referable to *Argopecten*, and the present author does not regard its sculpture as having significance above specific level.

In addition to the type-species, the following are also referable to *Argopecten*: the west African *flabella* (Gmelin); the western Atlantic *gibba* (Linné), *gibba nuclea* (Born), *gibba portusregii* (Grau), *noronhense* (E. A. Smith), *irradians* (Lamarck), *irradians concentrica* (Say), *irradians amplicostata* (Dall) and *flabella schrammi* (Fischer); the eastern Pacific *circularis* (Sowerby), *circularis aequisulcata* (Carpenter) and *purpurata* (Lamarck); the central Pacific, western Pacific and Indian Ocean *nux* (Reeve); the western Pacific (Japan, Philippine Islands and Siam) *pelseneeri* (Dautzenberg & Bavay); the Queensland, Australia *corymbiata* (Hedley).

KEY TO THE EASTERN PACIFIC SPECIES OF *Argopecten*

1. Shell quite convex and umbos strongly inflated
 2. Shell rather thick; left valve almost as convex as right; colors: black, brown, red, purple, lavender, pink, orange, yellow; adult shells averaging 66 mm in height *circularis* (Sowerby) (Cedros Island, Lower California to Paita, Peru; Galapagos Islands)
 2. Shell thinner; left valve much less convex than right; colors: red-brown, dark brown, mottled with white or yellow; adult shells averaging 80 mm in height *circularis aequisulcata* (Carpenter) (Santa Barbara, California to Bahia San Quintin, Lower California)
1. Shell less convex and umbos less inflated; ribs profusely lamellose along sides; interior with broad, flat ridge on lower $\frac{1}{3}$ of disk and hinge line black; colors: usually white with purple ribs, occasionally lavender or yellow ribs, sometimes mottled orange, white and brown, rarely all white

. *purpurata* (Lamarck)
(Corinto, Nicaragua to Coquimbo Province, Chile)

***Chlamys* (*Argopecten*) *circularis* (Sowerby) 1835**

Plate 32

Pecten tumidus Sowerby, 1835, p. 109. "Hab. ad Sanctam Elenam et ad Salango, Columbiae Occidentalis." [Santa Elena and Salango, Ecuador.]

[non] *Ostrea tumidus* Turton, 1819, p. 132. [= *Pecten similis* Laskey, 1811, p. 387, pl. 8, fig. 8. Western Atlantic, from Norway to west Africa; Mediterranean.]

[non] *Pecten tumidus* Hartmann in von Zieten, 1833. p. 68. [Fossil; Germany.]

Pecten circularis Sowerby, 1835, p. 110. "Hab. ad Sinum Californiae. (Guaymas). Found in sandy mud at a depth of seven fathoms."—Sowerby, 1842, p. 51, pl. 12, fig. 23. "California and St. Vincent's." [St. Vincent (Windward Islands, West Indies) record erroneous; undoubtedly based on specimens of *Chlamys* (*Argopecten*) *gibba* (Linné).]

[non] *Pecten circularis* Goldfuss, 1836, p. 76, pl. 99, figs. 10a, 10b. "Ex arena viridi Westphaliae." [Cretaceous of Westphalia, Germany.]

Pecten ventricosus Sowerby, 1842, p. 51, pl. 12, figs. 18, 19, 26. "St. Elena [Ecuador]; and young specimens brought from Calapan, Philippines, by Mr. Cuming." New name for *P. tumidus* Sowerby. [Philippines record erroneous.]

[?] *Pecten pomatia* Valenciennes, 1846, pl. 19, fig. 3. [Carpenter (1864, p. 528): "may be = *P. ventricosus*, jun."]

Pecten inca d'Orbigny, 1846, p. 663. New name for *P. tumidus* Sowerby.

Pecten ventricosus Sowerby. Küster, 1859, p. 100, pl. 28, figs. 1, 2. Fig. 3 incorrectly referred to *P. ventricosus* in text, but in plate index correctly referred to *P. gibbus* (Linné). "West-Columbia." [Ecuador.]

Pecten (*Argus*) *ventricosus* Sow. Mörch, 1861, p. 210. "Puntarenas [Costa Rica] . . . Bocorones [Boquerones, Nicaragua] . . . Realejo [El Realejo, Costa Rica]." [Also listed: "Var. coccinea; valva dextra lituris atris, intus alba. Sow. thes. f. 26.—Puntarenas . . . Var. maculis albis, violaceis et nigris. . . ." For status of *Argus* see Gray (1851) reference under *Chlamys islandica* (Müller), this paper.]

- Pecten (Argus) circularis* Sow. Mörch, 1861, p. 210. "Realejo et Puntarenas."
- Pecten (Dentipecten) circularis* Sowerby. Kobelt, 1887, p. 188, pl. 51, figs. 5-8. California to Mazatlan, Mexico.
- Pecten (Plagiectenium) ventricosus* Sowerby. Dall, 1898, p. 710. Pleistocene of San Pedro, San Diego and Lower California. "Living from Santa Barbara southward."
- Pecten (Plagiectenium) circularis* Sowerby. Arnold, 1906 [*ex parte*], p. 125, pl. 42, figs. 3-6; pl. 44, figs. 6, 6a, 6b, 7. [Fig. 7, holotype of *P. compactus* Dall, 1898, incorrectly referred to *P. circularis*; = *Chlamys (Argopecten) circularis aequisulcata* (Carpenter), 1864.] "Pliocene (?). Cholas Valley, near San Diego (Stearns)." Previous Pleistocene records cited. "Living. Gulf of California to Panama . . ."
- Pecten ventricosus* Sowerby. Dall, 1909, p. 256. "Gulf of Panama, south to Paita, Peru."
- Chlamys (Aequipecten) ventricosa* Sowerby. Lamy, 1909, p. 213. "Basse Californie."
- Pecten (Chlamys) circularis* Sowerby. Dall, 1921, p. 19. "Monterey, California, to Payta, Peru." [Under "Section" *Plagiectenium*.]
- Pecten ventricosus* Sowerby. Bosworth, 1922, p. 178. Pleistocene of NW Peru.
- [*non*] *Pecten circularis* Sb. Campbell, 1923, p. 40. "Near Canton [China], and at Chung Chow, Hongkong territory." [*non P. circularis*; sp. ?]
- Pecten (Plagiectenium) calli* Hertlein, 1925, p. 16, pl. 4, figs. 5-7.
- Pecten circularis* Sowerby. Dall & Ochsner, 1928, p. 98. Indefatigable Island, Galapagos Islands. ". . . believed to be Pliocene . . ."
- Chlamys ventricosus* (Sow.). Tomlin, 1928, p. 191.
- Pecten* cf. *circularis* Sowerby. Li, 1930, p. 255, pl. 1, fig. 8. Panama Bay. "Probably Gatun formation." ["Two right valves of *P. ventricosus* Sowb.", *fide* Pilsbry, 1932, p. 429.]
- Pecten fililextus* Li, 1930, p. 255, pl. 2, fig. 10. Panama Bay. Probably Gatun formation." ["A left valve of *Pecten ventricosus* Sowb.", *fide* Pilsbry, 1932, p. 429. The name *fililextus* meaningless and obviously a *lapsus calami* or typ. err.; correctly emended to *filitextus* by Pilsbry, *loc. cit.*]
- Pecten (Aequipecten) gibbus* (Linnaeus) variety *circularis* (Sowerby). Grant & Gale, 1931 [*ex parte*], p. 218, pl. 5, figs. 7a-7c. [Specimen figured = *Chlamys (Argopecten) circularis aequisulcata* (Carpenter).]

Chlamys (Plagioctenium) ventricosum (Sowerby). Bavay, 1936, p. 315.

Pecten (Plagioctenium) circularis Sowerby. Hertlein & Strong, 1946, p. 57. "Cedros Island, Lower California, and the Gulf of California, to Paita, Peru."

Aequipecten (Plagioctenium) circularis (Sowerby, 1835). Keen, 1958, p. 72, fig. 132.

Holotype: British Museum.

Type locality: Santa Elena, Ecuador.

Original description: Pect. testâ suborbiculari, tumidâ, subaequivalvi, aequilaterali, fusco alboque variâ, auriculis magnis, subaequalibus; costis radiantibus octodecim interstitiis latioribus, arcuatim striatis; valvâ alterâ sulcis profundioribus; long. 1.5, lat. 0.8, alt. 1.4 poll.

Additional description: Adult specimens averaging 65 mm in height and 70 in length, but proportions variable; both valves very convex, right slightly more than left. Umbos expanded, with beak of right valve strongly produced above hinge line. Right valve with 17 to 21 squarish ribs, flat and obscurely ridged on top, with a faint ridge on each side just below the top; interspaces narrow and produced beyond ventral margin; disk covered with very fine concentric lamellae, usually worn off on adult shells. Anterior auricle shallowly convex and with 4 to 6 faint ridges; auricle and adjacent submargin having fine concentric lamellae; byssal notch rather deep and ctenolium of 3 teeth. Posterior auricle shallowly convex, with 5 to 8 faint ridges; lamellae same as on anterior auricle; posterior sinus shallow. Left valve with narrower, sloping ribs, occasionally grooved on top; interspaces produced beyond ventral margin; disk covered with wavy concentric lamellae, more prominent than on right valve. Anterior auricle moderately concave and with 5 to 7 faint ridges; byssal sinus fairly deep; posterior auricle shallowly concave and with 8 to 10 low, narrow ridges; both auricles and adjacent submargins with fine concentric lamellae; posterior sinus shallow. Hinge structure strong; cardinal crura very pronounced on right valve and interlocking tightly with left valve; strong transverse striae on crura and provinculum; cardinal margin of right valve well folded over; prominent nodules at base of each auricle on both valves. Color range extensive; left valve almost always darker than right. From Gulf of California to Guatemala, various shades of red, pink, lavender, brown, orange and yellow, usually mottled; from Panama to Peru, same colors plus black, purple-black, deep purple and violet, frequently without mottling. Throughout range interior of right valve predominant-

ly white, but colored in varying degree with red, purple or brown; left valve pale brown to black-brown, but white along ventral margin.

Remarks: There is nothing in Sowerby's description of *Pecten ventricosus* that would separate it from certain specimens of *Chlamys circularis*; this species is certainly variable in convexity, obliquity and sculpture, but nowhere within its geographic range are found variations of either specific or subspecific importance.

Geographical range: Cedros Island, Lower California, Mexico, and the Gulf of California, to Paita, Peru; Galapagos Islands. Specimens taken at three Hancock stations accounted for the first Recent records of this species from the Galapagos.

Geochronological range: ?Pliocene, Pleistocene, Recent.

Bathymetric range: Recorded in 4 feet to 75 fathoms.

Ecological data: Found on rock, gravel, sand, sandy mud or mud bottoms; associated with kelp, corallines or gorgonians.

Hancock Expeditions Collecting Stations:

GALAPAGOS ISLANDS: 5-70 fathoms, sand and rock; sta. 173-34, 183-34, 187-34 (South Seymour I.; between Albany and James Is.; Albemarle I.).

ECUADOR: 2-10 fathoms, sand and rock; sta. 23-33, 209-33, 211-33, 217-33.

PANAMA: 2-15 fathoms, sand and rock; sta. 113-33, 251-34, 448-35, 959-39, 960-39.

COSTA RICA: 1½-30 fathoms, sand and mud; sta. 116-33, 253-34, 257-34, 469-35, 472-35, 478-35, 963-39.

WESTERN MEXICO: 5-20 fathoms, gravel, sand, mud; sta. 259-34, 765-38, 927-39.

GULF OF CALIFORNIA: 37 stations; 3-70 fathoms, sand and mud.

WESTERN LOWER CALIFORNIA: 15-24 fathoms, sand; sta. 617-37, 1031-40d2, 1037-40.

***Chlamys (Argopecten) circularis aequisulcata* (Carpenter) 1864**

Plate 33

Pecten (?*ventricosus*, var.) *aequisulcatus* Carpenter, 1864, p. 536.

[*Nomen nudum*.] "Of these forms . . . the diagnoses are written, and will probably appear in one of the scientific periodicals for 1864." Footnote: ". . . presumed . . . from the neighbourhood of Sta. Barbara."

Pecten v. *aequisulcatus* Carpenter, 1864, p. 540. [*Nomen nudum*.]
"Near San Pedro."

- [*non*] *Pecten ventricosus*, Sby., + *tumidus*, Sby. Gould in Carpenter, 1864, p. 592. [Carpenter commented, "Dead valves, of the form *aequisulcatus*. San Diego."; *aequisulcatus* a *nomen nudum*.]
- [*non*] *Pecten ventricosus*, Sby., + *tumidus*, Sby. Cooper in Carpenter, 1864, p. 599. [Carpenter commented, " = ? var. *aequisulcatus*, Cpr."; *aequisulcatus* a *nomen nudum*.]
- Pecten aequisulcatus*, ? n.s. Carpenter, 1864, p. 645. [First validation of name.] "Santa Barbara (Jewett); Sta. Barbara and San Diego (Cooper)."
- Pecten* (var.) *aequisulcatus* Carpenter, 1865, p. 179, Santa Barbara.
- Pecten* (var.) *aequisulcatus* Carpenter, 1865, p. 179. Santa Barbara. West coast of Central America, particularly northward from Panama.
- Pecten* (*Pecten*) *compactus* Dall, 1898, p. 707, pl. 34, fig. 5. Pleistocene (not Pliocene, as regarded by Dall) of Ventura County, California.
- Pecten* (*Plagiectenium*) *subventricosus* Dall, 1898, p. 707, pl. 29, fig. 8. Pleistocene (not Pliocene, as regarded by Dall) of Ventura County, California.
- Pecten* (*ventricosus* var. ?) *aequisulcatus* Cpr. Dall, 1898, p. 711. Pleistocene of San Pedro, San Diego and Lower California. "Living from Santa Barbara southward."
- Pecten* (*Plagiectenium*) *newsomi* Arnold, 1903, p. 113, pl. 11, figs. 1, 1a.
- Pecten* (*Plagiectenium*) *circularis* var. *aequisulcatus* Carpenter. Arnold, 1906, p. 132, pl. 50, figs. 1, 1a, 1b; also text figs. 1, p. 45 and 2, p. 46. "Santa Barbara to Pacific side of Lower California." Pleistocene: Ventura, San Pedro and San Diego, California; Lower California.
- [*non*] ?*Pecten* (*Aequipecten*) *aequisulcatus* Carpenter. Dautzenberg & Bavay, 1912, p. 19. Banda (Moluccas); Saleh Bay (Soembawa, or Sumbawa, Island, Indonesia); "reported with some doubt." [*non* *C. circularis aequisulcata* (Carpenter); sp. ?]
- Pecten* (*Chlamys*) *circularis aequisulcatus* Carpenter. Dall, 1921, p. 19. Santa Barbara, California, to Cape San Lucas, Lower California. [Under "Section" *Plagiectenium*.]—Oldroyd, 1924a, p. 58, pl. 42, figs. 1, 2. [Under "Section" *Plagiectenium* (sic).]
- Pecten* (*Chlamys*) *circularis aequisulcatus* Carpenter. Waterfall, 1929, table facing p. 78.
- Pecten* (*Aequipecten*) *gibbus* (Linnaeus) variety *circularis* Sowerby. Grant & Gale, 1931 [*ex parte*], p. 218, pl. 5, figs. 7a-7c. [*Pecten*

?*ventricosus* var. *aequisulcatus* Carpenter in synonymy.] “. . . as *aequisulcatus*, Santa Barbara, Calif., to Cape San Lucas, Lower Calif. (Dall, 1921).” [Figured specimen = *C. circularis aequisulcata* (Carpenter).]

Pecten (Aequipecten) circularis aequisulcatus Carpenter. Keep, 1935, p. 52, fig. 23.

Chlamys (Aequipecten) aequisulcatus Carpenter. Bavay, 1936, p. 314.

Plagiectenium circularis aequisulcatus Carpenter. Morris, 1952, p. 16, pl. 1, fig. 5; pl. 5, fig. 1.

Plagiectenium circularis aequisulcatum (Carpenter 1865). Fitch, 1953, p. 42, fig. 8. “Monterey Bay, California, to Cape San Lucas, Baja California.”

Pecten (Plagiectenium) circularis aequisulcatus Carpenter. Palmer, 1958, p. 71, pl. 3, figs. 1-3. “The types of this species consist of one left valve, marked “type,” and one double specimen, in the U. S. National Museum, no. 15645, with the label “San Diego.” [Under Pliocene Palmer cited Grant & Gale, 1931, but in that paper Pliocene records were given only for *P. circularis* Sowerby.]

Syntypes: U. S. National Museum.

Type locality: San Diego, California. Syntypes so labelled, *vide* Palmer, 1958, p. 71.

Original description (Carpenter, 1864, p. 645): Thinner and flatter than *ventricosus*, with narrower ribs.

Subsequent description (Carpenter, 1865, p. 179): *P. testa P. ventricosus* simili, sed tenuiore, minus ventricosa; costis pluribus angustioribus xx-xxi.; interstitiis (praecipue valva superiore) fere aequalibus; auriculis magis productis, acutis; sinu serrato; testa jun. interstitiis alte insculptis, laminis concentricis crebris, vix extantibus, interstitia, costas auriculasque transeuntibus. Long. 3.2, lat. 3.35, alt. 1.5.

Additional descriptive notes: This subspecies is the northern form of the typical and can be distinguished primarily by its thinner shell, flatter left valve and more subdued coloring. In adult specimens the ribs are more angulate than those of the typical and the concentric lamellae of the disk more prominent. The size of mature specimens is greater, the average height being 80 mm and the length 88. The author's collection contains a specimen from San Pedro measuring 98 mm in height and 106 in length, the largest for which any record could be found. Adult specimens are dark brown or red-brown, mottled with white or yellow; occasional juveniles are almost completely white, others red-orange or yellow and with white or brown mottling.

Remarks: The validity of this subspecies has been questioned by various authors. The criteria for separating the shell from that of the typical would seem to be weaker than is usually required for the recognition of subspecific rank, and gross anatomy studies by Dr. N. T. Mattox and graduate student R. Kleinknecht of the Hancock Foundation showed no apparent distinctions from the typical. However constant differences in shell structure cannot be ignored and the subspecies is geographically restricted, therefore the author feels that no change in its status is advisable.

Only one specimen of *Chlamys circularis aequisulcata* has been found on the California coast during the past seven years, according to Mr. John E. Fitch, research director of the California State Fisheries Laboratory at Terminal Island, San Pedro. In a recent conversation with the author, Mr. Fitch said that he has been unable to find any others in the course of his many field trips, and that marine laboratories, fishermen and divers have also been unsuccessful. Although water pollution is suspected of being a factor, no definite reason is known for the near disappearance of this subspecies.

Geographical range: Elkhorn Slough, Monterey Bay, California to Bahia San Quintin, western Lower California.

Geochronological range: Pleistocene, Recent.

Bathymetric range: From several inches below surface at low tide to about 25 fathoms, possibly deeper.

Ecological data: Found on sand or mud bottoms, often in eel grass beds; usually in bays or lagoons, also in quiet water just offshore.

Hancock Expeditions Collecting Stations:

SOUTHERN CALIFORNIA AND SANTA BARBARA ISLANDS: 32 stations; from just below surface at low tide to 15 fathoms, sand or mud.

***Chlamys* (*Argopecten*) *purpurata* (Lamarck) 1819**

Plate 34

Pecten purpuratus Lamarck, 1819, p. 166. "Habite les mers orientales et australes. . . . On le dit du Japon." [Eastern and southern seas. . . . Reported from Japan.]

Pecten purpuratus Lamarck. Conrad, 1831 [*ex parte*], p. 10, pl. 2, fig. 1. "Coast of Florida; also coast of Panama, and in Coquimbo Bay, in Chile." [In synonymy: *P. dislocatus* Say (1822, p. 260); = *Ostrea gibba* Linné, 1758, p. 698. Geographical range of *O. gibba*: North Carolina to Florida; Gulf of Mexico, Caribbean Sea and West Indies.]

Pecten purpuratus Lamarck. Sowerby, 1842, p. 52, pl. 15, fig. 113; pl. 16, figs. 123-125. Callao Bay, Peru.

[non] *Pecten purpuratus* Lamarck. De Kay, 1843, p. 174. "Southern coast [Atlantic, U.S.A.]." [= *Ostrea gibba* Linné.]

Pecten purpuratus Lamarck. Küster, 1859, p. 78, pl. 20, figs. 1-3. Peru and Chile.—Dall, 1909, p. 149, pl. 26, figs. 5, 6. "From Coquimbo, Chile, northward to Ecuador."—Bosworth, 1922, p. 178, pl. 25, fig. 9. Pleistocene of NW Peru.

Pecten (Plagioctenium) purpuratus Lamarck. Hertlein, 1925, p. 14, pl. 1, fig. 1; pl. 4, figs. 2, 4. Pliocene and Pleistocene of Chile. [Recent range same as Dall, 1909.]

Pecten (Aequipecten) purpuratus Lamarck. Grant & Gale, 1931, p. 207, pl. 4, figs. 2a-2c. Pliocene of San Fernando, California. [Also previous Pliocene, Pleistocene and Recent records.]

Pecten purpuratus Lk. Pilsbry & Lowe, 1933, p. 139. "San Juan del Sur [Nicaragua] and Montijo Bay [Panama]; dredged alive at Taboga Island [Panama]; Corinto [Nicaragua]."

Chlamys (Plagioctenium) purpuratum (Lamarck). Bavay, 1936, p. 315.

Holotype: Muséum National d'Histoire Naturelle, Paris.

Type locality: Here designated Callao, Peru.

Original description: P. testa alba, purpureo et nigro purpurascens varia; radiis 26, convexis; intus zona purpureo-nigricante.

Habite les mers orientales et australes. Mus. no. Mon cabinet. Espèce rare et très-belle. Ses oreillettes sont un peu inégales. Largeur, 112 millimètres. On le dit du Japon.

Additional description: Shell large, adult specimens averaging 105 mm in height and 120 in length; disk nearly circular, occasionally slightly oblique; moderately convex, left valve more so than right; hinge line more than half length of disk; auricles slightly unequal, either anterior or posterior being longer. Right valve with 19 to 26 broad and flat-topped ribs, smooth on top except for very fine concentric lines of growth, and with profusely lamellated ridges along sides; interspaces narrower and prominently lamellated, especially near ventral margin, lamellae occasionally forming low central ridge near margin. Anterior auricle with 3 to 5 imbricated riblets; byssal notch narrow and moderately deep, with ctenolium of 4 to 8 teeth. Posterior auricle squared, truncated, or with shallow sinus; 7 or 8 radiating ridges; entire auricle concentrically striated. Left valve with profusely lamellated ribs, fringed along sides; interspaces narrow, strongly lamellated, and with central ridges prom-

inent from ventral margin nearly to unbonal area. Both auricles covered with concentric striae and having 7 or 8 low ridges; anterior auricle with shallow byssal sinus, posterior same shape as that of right valve. Cardinal crura fairly strong to very strong; crura and provinculum black or very deep brown except in yellow-white or white specimens, in which that area is white; heavy nodule at base of each auricle. Rest of internal structure unique after shell attains height of about 75 mm: broad and flat semicircular ridge forms in each valve, reaching from anterior to posterior submargin; top edge of ridge is about two-thirds to three-quarters of distance from hinge line to ventral margin; ridge is thickest in its center and tapers above and below. Color range fairly extensive: most common form white with purple ribs, variants having ribs of pink, pink and purple or pale to deep brown, often mottled; less common colors solid orange, yellow-white, white, and orange mottled with purple-brown and white. Interior with prominent concentric band of brown, purple-brown, purple or violet, except in yellow-white or white specimens, which have white interior.

Remarks: Although somewhat variable, this species is very distinct and easily recognizable. On the basis of available material the maximum length appears to be about 150 mm.

Lamarck's report of this species from Japan was obviously erroneous.

Geographical range: Corinto, Nicaragua, to Coquimbo Province, Chile.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Shallow water inshore to 50 fathoms.

Ecological data: Found on rock, shale or sand bottoms, occasionally associated with algae.

Hancock Expeditions Collecting Stations:

PERU: 8 stations; one each at Lorenzo and Fronton Islands, near Callao, six in Independencia Bay; 5-10 fathoms, rock or sand.

COSTA RICA: Port Parker; 5 fathoms, sand, sta. 468-35.

Subgenus **LEPTOPECTEN** Verrill 1897

Leptopecten Verrill, 1897, p. 69. Type species (by monotypy): *Pecten Monotimeris* Conrad, 1837, p. 238, pl. 18, fig. 10 [= *Chlamys (Leptopecten) latiaurata monotimeris* (Conrad)]; type locality: San Diego, California.

Original diagnosis: Shell thin, translucent, oblique, broadly rounded, with strong, rounded radial ridges or folds, like corrugations, which

appear in reverse on the interior surface. The internal ribs are not angulated by a deposit of shell, nor distinctly thickened. Margin with broad scallops. The exterior surface is covered with fine divergent camptonectes sculpture, both on the ribs and intervals. The ribs do not increase in number with age, but become broader and more flattened. Auricles large and broad, thin, corrugated. Byssal notch large and deep. Pectinidial teeth prominent. Hinge-plate thin and but little differentiated. Cardinal ridge thin and small, close to the ligament, crossed by fine incisions. The resilial pit is small, but projects beyond the thin hinge-plate in the left valve.

This is a peculiar group, remarkable for its thin but strongly corrugated oblique shells, with fine camptonectes sculpture.

G. Monotimeris (Con.), from the California coast, is the only species studied.

Additional diagnosis: Shell moderately to very thin, but translucent only in type species. Ribs often rather angulate, especially in mature specimens. Interior surfaces of interspaces often flat and angulately ridged, except in type species. Sculpture delicate and variable.

Remarks: Although Verrill based *Leptopecten* on a single species, he supplied a unit to which we can logically refer a number of closely related species. The subgenus is characterized by thin, broadly rounded shells, slightly to extremely oblique, with long hinge line and large auricles. The following species also belong to *Leptopecten*: the eastern Pacific *latiauratus* Conrad, *palmeri* Dall, *velero* Hertlein, *velero biolleyi* Hertlein, *euterpes* Berry and *tumbezensis* d'Orbigny, and the western Atlantic *bavayi* Dautzenberg and *linki* Dall. This subgenus is apparently restricted to North and South America.

KEY TO THE EASTERN PACIFIC SPECIES OF *Leptopecten*

1. 17 to 19 ribs; known maximum altitude 7.1 mm; ribs low and broad, with alternate ribs stronger; disks unsculptured *euterpes* (Berry)
(Acapulco, west Mexico)
1. 16 ribs or less
 2. Shell very thin and translucent (or nearly so); disks unsculptured (interspaces very infrequently having distant concentric lamellae) *latiaurata monotimeris* (Conrad)
(Monterey Bay, California, to Cape San Lucas, Lower California)

2. Shell opaque

3. Disks without sculpture (interspaces concentrically lamellose in juvenile stage only)

4. Beak closer to anterior margin; posterior auricles longer than anterior; obliquity pronounced; shell rather thick; no central ridges in interspaces
 *tumbezensis* (d'Orbigny)
 (Gulf of California to Paita, Peru)

4. Beak at or very near center of shell; auricles of nearly equal length; obliquity slight, if any; shell rather thin; central ridges almost always present in interspaces
 *palmeri* (Dall)
 (Gulf of California only)

3. Disks with sculpture (lamellose or imbricate)

5. Posterior auricles sharply pointed

6. Posterior auricles produced to or beyond margins of disks; adult altitude averaging 20 mm; 12-16 ribs
 *latiaurata* (Conrad)
 (Point Reyes, California to Cape San Lucas, Lower California; southern Gulf of California)

6. Posterior auricles not produced to margins of disks; occasionally every third rib or pair of ribs on left valve higher; maximum altitude 9 mm; 12-13 ribs
 *velero biolleyi* (Hertlein & Strong)
 (Punta Abreojos, western Lower California to La Libertad, Ecuador)

5. Posterior auricles not sharply pointed (their lateral margins nearly right angle to hinge); each third rib on left valve higher; central riblet in most interspaces of right valve; maximum altitude 13 mm; 16 ribs
 *velero* (Hertlein)
 (Las Animas Bay, Gulf of California to Puna, Gulf of Guayaquil, Ecuador)

***Chlamys* (*Leptopecten*) *latiaurata* (Conrad) 1837**

Plate 35, fig. 1

Pecten latiauratus Conrad, 1837, p. 238, pl. 18, fig. 9. "Inhabits below the efflux of the tide near Sta. Diego and Sta. Barbara."

[non] *Pecten lati-auratus* Conrad. Sowerby, 1842, p. 57, pl. 12, figs.

- 20, 21. "*P. Mesotimeris*, Conrad, inclusus?" [= *Chlamys* (*Leptopecten*) *latiaurata monotimeris* (Conrad), 1837. "*Mesotimeris*" a *lapsus calami* for *monotimeris*.]
- [non] *Pecten tunica* Philippi, 1844, p. 100, pl. 1, fig. 3. "Sandwich Islands." [= *Chlamys* (*Leptopecten*) *latiaurata monotimeris* (Conrad), 1837.] In index: "*tunica* Ph. ist *lateauratus* [sic] Jay." ["Jay" a *lapsus calami* for Conrad; locality (now Hawaiian Islands) incorrect.]—Paetel, 1890, p. 234. "*tunicus* Phl. ist *latiauritus* [sic] Conrad." [Paetel's misspelling of *latiauratus* followed by subsequent authors, and first corrected by Grant & Gale, 1931.]
- [non] *Pecten Lati-auritus* Lamarck. Chenu, 1845, pl. 31, figs. 10-12b. ["Lamarck" obviously erroneous; figures represent *Chlamys* (*Leptopecten*) *latiaurata monotimeris* (Conrad.)]
- [non] *Pecten latiauritus* Conrad. Reeve, 1852, sp. 5, pl. 1, fig. 5. [= *Chlamys* (*Leptopecten*) *latiaurata monotimeris* (Conrad).]
- Pecten latiauritus* Conrad. Kobelt, 1888, p. 203, pl. 54, figs. 7, 8. "an der Westküste von Nordamerika, besonders an Californien."
- Pecten latiauritus* [sic]. Keep, 1888, p. 167.
- Pecten* (*Chlamys*) *latiauritus* Conrad. Dall, 1898, p. 709. [*P. tunica* Philippi in synonymy; see above.] "Pleistocene of San Pedro Hill and San Diego at Coronado Beach. Also living."—Arnold, 1903, p. 111, pl. 12, figs. 2, 2a. Pleistocene records from Santa Barbara, San Pedro and San Diego. Living: Santa Barbara to San Diego. —Arnold, 1906, p. 115, pl. 46, figs. 2, 2a, 3, 3a. Pliocene: Third Street Tunnel, Los Angeles. Previous Pleistocene records cited. Living: Monterey; Santa Barbara to San Diego.
- Pecten* (*Chlamys*) *latiauritus* Conrad var. *delosi* Arnold, 1906, p. 130, pl. 46, figs. 9, 9a, 10, 10a. Living: Santa Catalina Island, in 15 fathoms; Santa Barbara; Monterey. Pleistocene: Deadman Island, San Pedro.
- Pecten* (*Chlamys*) *latiauritus* Conrad. Dall, 1921, p. 19. Monterey, California, to Lower California. [Under "Section" *Leptopecten*.] —Oldroyd, 1924a, p. 57, pl. 22, fig. 2. [Under "Section" *Leptopecten*.]
- Pecten* (*Aequipecten*) *latiauratus* Conrad. Grant & Gale, 1931, p. 203. Previous Pliocene, Pleistocene and Recent records cited.
- Pecten* (*Leptopecten*) *latiauratus* Conrad. Hertlein, 1935, p. 314. "Monterey, California to Gulf of California (I. S. Oldroyd); ?San Francisco Bay, California (Packard). Pliocene to Recent."—Hertlein & Strong, 1946, p. 59. "Off Point Reyes, California [38° N], to Cape San Lucas, Lower California."

Chlamys (Plagioctenium) latiauratum [sic] Conrad. Bavay, 1936, p. 315.

Leptopecten latiauratus Conrad. Morris, 1952 [*ex parte*], p. 16, pl. 1, fig. 3; pl. 5, fig. 4. [Figures = *Chlamys (Leptopecten) latiaurata monotimeris* (Conrad).] "... San Francisco to Gulf of California."

Leptopecten latiauratus Conrad. Abbott, 1954 [*ex parte*], p. 365, pl. 34, fig. i. [Figure = *Chlamys (Leptopecten) latiaurata monotimeris* (Conrad).]

Holotype: Academy of Natural Sciences, Philadelphia.

Type locality: San Diego, California.

Original description: Shell inequilateral, thin, compressed; ribs fourteen, flattened on the back, slightly sulcated; interstices transversely striated; ears very wide, unequal, both acutely angulated at the extremity; colour reddish brown and white, variegated or spotted.

Additional Description: Shell rather thin, slightly oblique and moderately convex; equilateral or nearly so; adult specimens averaging 20 mm in height and length. Hinge line almost always longer than disk in juvenile stage; in adult stage infrequently longer, usually slightly shorter. Both valves with 12 to 16 rounded ribs (actually corrugations of disk), rather flat on top and occasionally with a central groove; interspaces about same width as ribs and in some specimens having one or two low radial ridges; concentric lamellae covering disk, quite profuse in juvenile stage but less prominent in adult. Anterior auricles longer than posterior, former projecting beyond margin of disk, latter seldom reaching to margin; anterior auricle of right valve having 4 to 7 imbricated riblets, other auricles having 4 to 8 riblets and fine concentric lamellae. Reverse surfaces of interspaces flat and angulated. Colors: red, pink-red, orange, yellow, pale yellow-brown to deep brown, white; usually mottled with white or paler shade of basic color.

Remarks: Arnold based his subspecies *delosi* on only two distinguishing features: "... its extremely long hinge line and prominently lamellated interspaces." Since neither feature is uncommon among juvenile specimens of *latiaurata*, and since Arnold's type measured only 12 mm in height, *delosi* is here synonymized.

Arnold (1906, p. 116) commented: "A pair of valves in the U. S. National Museum (No. 96964), from U. S. Fish Commission Station No. 2840, Santa Barbara Islands, is labeled "*P. tumbezensis* Orb." This shell is probably an albino variety of *P. latiauritus*, having just a touch of color on the interior of the posterior ear of the left valve." The author recently examined that shell and it is unquestionably an albino

specimen of *C. latiaurata*. Dall's label reads: "Pecten tumbezensis (+ aspersus Sby.) Orb. = *P. sowerbyi* Reeve, Thesaurus [*sic*] f. 4, 1852; very close to *P. latiauritus* Conr." Arnold's phrase, "A pair of valves," is misleading; the valves are now separated but match perfectly. However, it is very doubtful that the animal was still alive when the shell was taken (even though it may still have been attached to the valves), for the specimen was found in green mud at a depth of 276 fathoms; no other specimen has been recorded living in the green mud so common to deep water stations off the southern California coast, nor has any been recorded from even half that depth. No doubt the animal died and the valves, still attached, drifted or were carried to deeper water.

This species differs from its subspecies *monotimeris* in having a thicker shell, longer hinge line, acutely pointed auricles, less pronounced obliquity, higher and narrower ribs, and concentric lamellae on the disks.

Geographical range: Point Reyes, California (38° N), to Cape San Lucas, Lower California, Mexico, and north to Espiritu Santo Island in the Gulf of California; Guadalupe Island, Mexico (180 miles west of central Lower California). Previously this species had been found as far south as Cape San Lucas but not in the Gulf; had Mrs. Oldroyd said "to but not in the Gulf of California" her statement would have been correct at the time it was written. The Hancock expeditions took specimens of *latiaurata* in bottom sample 2197, in 6 fathoms off San Gabriel Bay, Espiritu Santo Island, thus establishing for the first time its presence in the Gulf; the location is about 125 miles north of the mouth of the Gulf.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Recorded in 1 foot (minus tide) to 125 fathoms.

Ecological data: Found attached to rocks or pilings in shallow water; in deeper water on rock, shale, gravel or sand bottoms, often attached to calcareous algae.

Hancock Expeditions Collecting Stations:

SOUTHERN CALIFORNIA—71 stations; 3-80 fathoms, rock, gravel, sand.

GULF OF CALIFORNIA—bottom sample 2197, 6 fathoms.

Chlamys (Leptopecten) latiaurata monotimeris (Conrad) 1837
Plate 35, fig. 2

Pecten Monotimeris Conrad, 1837, p. 238, pl. 18, fig. 10. "Inhabits with the preceding [*P. latiauratus* Conrad]." "... below the efflux of the tide near Sta. Diego and Sta. Barbara."

- Pecten lati-auratus* Conrad. Sowerby, 1842, p. 57, pl. 12, figs. 20, 21.
“*P. Mesotimeris*, Conrad, inclusus?” [Sowerby’s description and figures actually of *P. Monotimeris* Conrad; “*Mesotimeris*” a *lapsus calami* for *Monotimeris*.]
- Pecten tunica* Philippi, 1844, p. 100, pl. 1, fig. 3. “Sandwich Islands.” In index: “*tunica* Ph. ist *lateauratus* [sic] Jay.” [“Jay” a *lapsus calami* for Conrad; locality (now Hawaiian Islands) incorrect.]—Paetel, 1890, p. 234. “*tunicus* Phl. ist *latiauritus* [sic] Conr.” [Paetel’s misspelling of *latiauratus* followed by subsequent authors, and first corrected by Grant & Gale, 1931.]
- Pecten Lati-auritus* Lamarck. Chenu, 1845, pl. 31, figs. 10-12b. [“Lamarck” obviously erroneous; figures represent *P. Monotimeris* Conrad.]
- Pecten latiauritus* Conrad. Reeve, 1852, sp. 5, pl. 1, fig. 5. [Reeve’s description and figure actually of *P. Monotimeris* Conrad.]
- Chlamys (Leptopecten) Monotimeris* Conrad. Verrill, 1897, p. 69. “. . . from the California coast.”
- Pecten latiauritus* var. *monotimeris* Conrad. Dall, 1898, p. 709. “Pleistocene of San Pedro Hill and San Diego at Coronado Beach. Also living.”
- Pecten latiauritus* var. *fucicolus* Dall, 1898, p. 710. “With the last [var. *monotimeris*], and living on fuci, south to Cape San Lucas [Lower California].”
- Pecten (Chlamys) latiauritus* Conrad var. *monotimeris* Conrad. Arnold, 1906, p. 131, pl. 46, figs. 4, 5, 5a. Living: Fort Point, San Francisco; Santa Barbara to San Diego. Pleistocene: Santa Barbara, Ventura, San Pedro, Newport, San Diego.
- [?] *Pecten (Chlamys) latiauritus* Conrad var. *fragilis* Arnold, 1903, p. 112, pl. 12, fig. 8. Pleistocene: San Pedro.
- [non] *Pecten fragilis* Defrance, 1825, p. 251.
- [non] *Pecten fragilis* Jeffreys, 1876, p. 424. [= *P. biscayensis* Locard, 1888, p. 272.]
- [non] *Pecten fragilis* Jeffreys 1879, p. 561, pl. 45, fig. 1. [= *Hyalopecten dilectus* Verrill, 1897, p. 80.]
- [?] *Pecten (Chlamys) latiauritus* Conrad var. *cerritensis* Arnold, 1906, p. 129, pl. 46, figs. 6, 7. “Pleistocene . . . at San Pedro and San Diego.” New name for *P. latiauritus fragilis* Arnold, non *P. fragilis* Jeffreys.
- Pecten (Chlamys) latiauritus monotimeris* Conrad. Oldroyd, 1924a, p. 57, pl. 40, figs. 1, 2. Monterey, California, to the Gulf of California [Under “Section” *Leptopecten*.]

Pecten (Chlamys) latiauritus fucicolus Dall. Oldroyd, 1924a, p. 58.
[Under "Section" *Leptopecten*.]

Pecten cf. *latiauritus fucicolus* Dall. Li, 1930, p. 255, pl. 2, fig. 11.
"Mouth of the Rio Grande near La Boca about one mile from the mainland in Panama Bay." [= *Pecten tumbezensis* d'Orbigny, *vide* Pilsbry, 1932, p. 429.]

Pecten (Aequipecten) latiauratus Conrad var. *monotimeris* Conrad.
Grant & Gale, 1931, p. 204, pl. 4, figs. 3, 6. Previous Pleistocene and Recent records.

Chlamys (Plagiectenium) latiauritum [sic] var. *monotimeris* Conrad.
Bavay, 1936, p. 315.

Pecten (Leptopecten) latiauratus monotimeris Conrad. Proc. Conch. Club So. Calif., 1944, no. 35, p. 9. [Same records as Dall, 1931]—Hertlein & Strong, 1946, p. 60. Monterey Bay, California, to Cape San Lucas, Lower California.

Leptopecten latiauratus Conrad. Morris, 1952 [*ex parte*], p. 16, pl. 1, fig. 3; pl. 5, fig. 4. [Figures = *Chlamys (Leptopecten) latiaurata monotimeris* (Conrad)]—Abbott, 1954 [*ex parte*], p. 365, pl. 34, fig. i. [Figure = *Chlamys (Leptopecten) latiaurata monotimeris* (Conrad).]

Holotype: Academy of Natural Sciences, Philadelphia.

Type locality: San Diego, California.

Original description: Shell ovate, oblique, thin, compressed, with concentric striae; ribs thirteen, rounded; ears subequal; colour brown, with white stripes and spots.

Var. A. Orange, with white divaricating stripes.

Inhabits with the preceding [*latiaurata*]. The young occasionally found attached to Fuci by a slender byssus.

Additional description: Shell very thin, moderately to extremely oblique, convexity moderate, length and height about the same; adult specimens averaging 28 mm in altitude, occasionally 38 or 40. Hinge line $\frac{2}{3}$ to $\frac{4}{5}$ length of disk. Right valve more convex than left. Both valves with 9 to 13 broadly rounded ribs (actually corrugations of disks), somewhat higher on left. Ribs and interspaces almost always smooth, but sometimes having distant concentric growth lines or striae; distinct radial ridges only very infrequently present on ribs and in interspaces. Posterior auricles longer than anterior, with varying number of low radial ridges, finely concentrically striated. Anterior auricles, though shorter than posterior, produced to margins of disks and occasionally beyond; that of right valve having 3 to 5 imbricated riblets, that of left

valve being same as posterior auricles. Byssal notch rather deep and having ctenolium of 5 to 8 teeth. Interior usually smooth, but on infrequent specimens reverse surfaces of interspaces thickened and angulated. Colors: orange, pale yellow-brown to deep brown; white zigzag streaks almost always present.

Remarks: The subspecies differs from the typical by its shorter hinge line, shorter and less acutely pointed auricles, greater obliquity, lower and broader ribs, and either completely smooth or very weakly sculptured surfaces of disks.

Conrad's "Var. A." must be disregarded, for it was based on a specimen distinguished only by its orange color, a color very commonly found in this subspecies.

While the subspecies is frequently found attached to clumps of seaweed, the typical never is.

Geographical range: Monterey Bay, California, to Cape San Lucas, Lower California, Mexico.

Geochronological range: Pleistocene, Recent.

Bathymetric range: Apparently (from available data) never more than a few feet below the surface.

Ecological data: Usually attached by byssus to seaweed or eel grass, less frequently to pilings, bottoms of boats, calcareous algae or rocks.

Hancock Expeditions Collecting Stations:

SOUTHERN CALIFORNIA: 28 stations.

WESTERN LOWER CALIFORNIA, MEXICO: 9 stations.

***Chlamys (Leptopecten) palmeri* (Dall) 1897**

Plate 36

Pecten palmeri Dall, 1897, p. 85. ". . . near the head of the Gulf of California."

Pecten (Aequipecten) palmeri Dall. Arnold, 1906, p. 136, pl. 50, figs. 2, 2a, 3, 3a. "Near head of Gulf of California (E. Palmer)."

"*Pecten (Aequipecten) palmeri* Dall." Grant & Gale, 1931, p. 206.

[Listed in synonymy of *P. tumbezensis* d'Orbigny, citing "Arnold, . . . , p. 136 in part, pl. 50, figs. 2, 2a, only, 1906." Arnold's figures 2 and 2a not *P. tumbezensis*, representing, as he said, a "co-type" of *P. palmeri*.]

Aequipecten (Leptopecten) palmeri (Dall, 1897). Keen, 1958, p. 70, fig. 128.

Holotype: U. S. National Museum.

Type locality: Here designated Guaymas, Sonora, Mexico (northern Gulf of California).

Original description: Shell thin, orbicular, compressed, equilateral, white to yellowish-brown, with concentric or zigzag narrow bands or flecks of dark rose color; 15 strong ribs rounded in the young, mesially keeled and longitudinally threaded in the adult, separated by narrower channelled interspaces, each with a mesial thread; all crossed by lamellose, concentric, rather sparsely distributed elevated lines; submargins and ears closely radially threaded with imbricated threads. Both valves similarly sculptured; alt. 47.5, lat. 53, diameter about 20 mm.

Additional descriptive notes: Hinge line slightly more than $\frac{2}{3}$ length of disk; anterior auricles slightly longer than posterior, that of right valve having 4 to 6 strong radial riblets crossed by concentric lamellae, a sharp, narrow byssal notch and a ctenolium of 5 or 6 teeth; mesial threads in interspaces occasionally absent; reverse surfaces of interspaces flat and angulated; prominent crura at base of each posterior auricle. Color range including red, rose-pink, red-brown, yellow-brown, yellow-white and white; banded and blotched.

Geographical range: Known only from the Gulf of California; unique in that respect, being the only species of Pectinidae so restricted.

Geochronological range: Recorded only from the Recent.

Bathymetric range: On rocks at low tide, and to 50 fathoms.

Ecological data: Found on rock, sand, sandy mud or mud bottoms.

Hancock Expeditions Collecting Stations:

GULF OF CALIFORNIA: 7 stations; Concepcion Bay north to San Felipe Bay; $2\frac{1}{2}$ to 45 fms., rock, sand.

Chlamys (Leptopecten) velero (Hertlein) 1935

Plate 37

Pecten (Leptopecten) velero Hertlein, 1935, p. 316, pl. 19, figs. 13, 14.

Bahia Honda, Veragua, Panama; Mazatlan, Mexico; Maria Madre Island, Tres Marias Group, Mexico.—Hertlein & Strong, 1946, p. 60. Mazatlan, Mexico to Panama.

Aequipecten (Leptopecten) velero (Hertlein, 1935). Keen, 1958, p. 70, fig. 130. Mazatlan, Mexico to Panama.

Leptopecten velero Hertlein 1935. Soot-Ryen, 1957, p. 5. "Puna [Gulf of Guayaquil, Ecuador], 8 fathoms, 3 right and 2 left valves, maximal length 16.8 mm, height 16.5 mm."

Holotype: California Academy of Sciences, San Francisco.

Type locality: Bahia Honda, Veragua, Panama, in 3 to 9 fathoms.

Original description: The type is a left valve with 16 strong ribs, of which every third rib is higher than the intervening ones; the two ribs

on the margins are a little stronger than those on the middle; strong imbricating lamellae cross the ribs. The anterior ear is ornamented by about six to seven imbricated riblets and the posterior shows about five such riblets. The exterior of the shell is colored pink with whitish and brownish spots. The hinge line has transverse striations; the ribs are shown on the interior of the shell by strong ridges and hollows. Other specimens sometimes have pairs of raised ribs instead of only one. Type, altitude approximately 6.4 mm.; length of hinge line approximately 6.2 mm.

Additional descriptive notes: The right valve is moderately convex, the left flattish. Every third rib of the left valve is angular and has prominent concentric lamellae, the other ribs being rounded and much smoother; one or two riblets are present in the interspaces. On the right valve a low central riblet (rarely two) occurs between the major ribs, both the ribs and interspaces being concentrically lamellated; a well-defined byssal notch is present and a ctenolium of five teeth; the anterior auricle has five imbricated riblets, the posterior five or six. The left valve is pink, red, or red-brown, with white and brown markings; the right valve is either much paler than the left or white. Fully grown specimens attain an altitude of 16 or 17 mm.

Geographical range: Las Animas Bay, Gulf of California, to Puna, Gulf of Guayaquil, Ecuador. Mazatlan, Mexico, was the previously recorded northern limit, but specimens in the author's collection from Las Animas Bay extend the range by about 570 miles.

Geochronological range: Reported only from the Recent.

Bathymetric range: Recorded in 3 to 40 fathoms.

Ecological data: Found on rock, gravelly sand, sand, and mud bottoms.

Hancock Expeditions Collecting Stations:

ECUADOR: La Libertad, 3-5 fathoms, sand, sta. 9-33 and bottom sample 504; Santa Elena Bay, 8-10 fathoms, rock, sta. 209-34.

Chlamys (Leptopecten) velero biolleyi (Hertlein & Strong) 1946

Plate 38

Pecten (Leptopecten) velero biolleyi Hertlein & Strong, 1946, p. 60, pl. 1, fig. 6. "... dredged in 12 fathoms (22 meters) in Lat. 10° 55' 45" N., Long. 85° 49' 05" W., Port Parker, Costa Rica, on bottom of sandy mud and crushed shells."—Hertlein & Strong, 1955, p. 181. "... Guayabo Chiquito Bay, Panama, . . . 25-64 meters, . . . gray mud bottom."

Aequipecten (Leptopecten) velero biolleyi (Hertlein & Strong, 1946).

Keen, 1958, p. 70, fig. 131. Port Parker, Costa Rica to Panama.

Holotype: California Academy of Sciences, San Francisco.

Type locality: Port Parker, Costa Rica.

Original description: Shell small, rather thin, hinge long; color white and brown arranged in concentric bands; anterior ear of right valve with large byssal notch and ctenolium, ornamented by three ribs; ventral margin broadly rounded; left ear large and broadly notched, ornamented by about four ribs; valve ornamented by about 12 to 13 rather high sharply triangular ribs which are separated by considerably wider interspaces, ribs and interspaces with strong, dense, fringing imbricating lamellae; when slightly worn the tops of the ribs are smooth; the ribs near the anterior and posterior margins are somewhat higher than the others and sometimes every third rib or pair of ribs is slightly raised; left valve similar to right except that it lacks the large byssal notch and the right ear is ornamented by about 4 or 5 ribs and the left ear is ornamented by 5 or 6 ribs; on some left valves every third rib is raised higher than the intervening ones. Length, 6.9 mm; height, 6.6 mm.

Remarks: From *Chlamys (Leptopecten) velero* the subspecies differs in having fewer ribs, heavier shell and greater tumidity. The coloring is darker, both valves being medium to very dark brown, with white markings. Fully adult specimens average 8 or 9 mm in height.

Geographical range: Punta Abreojos, western Lower California, and Gulf of California, to La Libertad, Ecuador. This subspecies had previously been reported only from Banderas and Guatulco Bays, Mexico, Port Parker, Costa Rica, and Guayabo Chiquito Bay, Panama. Collections at Hancock stations extended the northern range by about 800 miles and the southern by about 700.

Geochronological range: Known only from the Recent.

Bathymetric range: Recorded in 10 to 120 fathoms.

Ecological data: Found in either sand or mud bottoms.

Hancock Expeditions Collecting Stations:

ECUADOR: La Libertad, 15 fathoms, bottom sample 502; San Francisco Bay, 4-10 fathoms, bottom samples 510, 583.

COLOMBIA: Port Utria, 20 fathoms, mud, sta. 233-34; Gorgona Island, 10-20 fathoms, bottom sample 584.

PANAMA: off Bahia Honda, 30-35 fathoms, sand, mud, sta. 244-34; Secas Islands, 25 fathoms, mud, sta. 250-34; Jicarita Island, 24 fathoms, bottom sample 310.

COSTA RICA: Port Culebra; 10 fathoms, mud, sta. 253-34.

GULF OF CALIFORNIA: Coronados Islands, 100-120 fathoms, sta. 523-36; Carmen Island, 25 fathoms, bottom sample 2188.

WESTERN LOWER CALIFORNIA: Punta Abreojos; 28-30 fathoms, bottom sample 2199.

***Chlamys (Leptopecten) euterpes* (Berry) 1957**

Plate 39

Pecten (Leptopecten) euterpes Berry, 1957, p. 75. "6-10 fms., off Acapulco, Mexico."

Aequipecten (Leptopecten) euterpes (Berry, 1957). Keen, 1958, p. 70, fig. 127.

Holotype: Stanford University.

Type locality: 6-10 fathoms, off Acapulco, west Mexico.

Original description: Shell small, thin, compressed, moderately oblique; hinge long; ears large, the anterior slightly the wider and ornamented by 7 to 9 finely lamellose radial threads; notch deep, subacute; ctenolium septemdentate; posterior ear weakly furrowed, the ribs nearly obsolete. Right valve with 17 to 19 low, rather broad, gently rounded radial ribs set off by incised lines; alternate ribs on the older portion of the shell a little stronger and the 2 or 3 posterior ribs yet more emphasized; toward the antero-dorsal angle 3 or 4 ribs are narrower and bear a delicately beaded keel on their ridges. Left valve a trifle more convex, but similarly sculptured except that about every third rib a trifle stronger than the others. Color either Acajou Red with a little dim speckling, or clear Apricot Yellow, the right valve always a trifle the lighter. Max. long. of holotype 7.4, alt. 7.1, max. diam. 2.0 mm.

Type-Locality: 6-10 fms., off Acapulco, Mexico; M. W. Williams, 6-7 Apr., 1937.

Comparisons: This is a tiny but gay little scallop which differs strongly from the associated *C. velero* Hertlein in the width and flatness of the ribs, as well as in the lack of cross-lamellation on the disk, and the lively coloring.

Remarks: Dr. Berry kindly presented the author with a specimen of this species, a paratype measuring 5 mm in height and 5.5 mm in length. That it differs from *C. velero* is quite apparent, but whether those differences entitle it to specific or subspecific rank seems debatable. *C. velero biolleyi* Hertlein appears to differ from *C. velero* in more respects than this species. However, until more material is available and a series of specimens can be studied, no taxonomic change is advisable.

Chlamys (Leptopecten) tumbezensis (d'Orbigny) 1846

Plate 40

Pecten aspersus Sowerby, 1835, p. 110. "Hab. ad Tumbez, Peruviae."
 [non] *Pecten aspersus* Lamarck, 1819, p. 167. "Habite . . ." [= *P. septemradiatus* Müller, 1776, p. 248.]

Pecten Tumbezensis d'Orbigny, 1846, p. 663. "Tumbez, Peru (Cum-
 ing)." New name for *P. aspersus* Sowerby, non *P. aspersus*
 Lamarck.

Pecten Sowerbyi Reeve, 1852, sp. 4, pl. 1, fig. 4. "Tumbez, Peru."
 New name for *P. aspersus* Sowerby, non *P. aspersus* Lamarck.

[non] *Pecten Sowerbii* Guilding [MS, 1826]. Sowerby, 1842, p. 53, pl.
 12, fig. 17. "... from St. Vincents." [West Indies; = *Ostrea gibba*
 Linné, 1758, p. 698.]

Pecten paucicostatus Carpenter, 1864, p. 536. [*Nomen nudum.*] "Of
 these forms . . . the diagnoses are written, and will probably be
 found in one of the scientific periodicals for 1864." Footnote:
 "presumed . . . from the neighbourhood of Sta. Barbara."—Car-
 penter, 1864, p. 614. [*Nomen nudum.*] "Sta. Barbara Is. Described
 from Col. Jewett's valves."

Pecten paucicostatus ? n. s. Carpenter, 1864, p. 645. "Somewhat re-
 sembling very young *caurinus*; but ribs fewer, stronger." [First
 validation of name, although comparison with *caurinus* misleading.
 Two syntypes in U. S. National Museum labelled by Carpenter
 "Types Sta. Barbara Jewett Cooper Catalina Id.", and two syn-
 types in Redpath Museum labelled by Carpenter "Type Sta. Bar-
 bara Jewett (? Nicaragua).", *fide* Palmer, 1958, p. 72. See *Re-*
marks under *Pecten* (?var.) *squarrosus* Carpenter, this paper,
 concerning Jewett's localities.]

Pecten paucicostatus Carpenter, 1865, p. 179. [Complete description.]

Pecten (Plagiopecten) paucicostatus Carpenter. Arnold, 1906 [*ex*
parte], p. 137, pl. 39, figs. 3, 3a, 4. "Gulf of California." [Figures
 = *C. tumbezensis* (d'Orbigny).]

Pecten (Chlamys) paucicostatus Carpenter. Dall, 1921, p. 19. Catalina
 Island, California, to Gulf of California.—Oldroyd, 1924a [*ex*
parte], p. 56, pl. 41, figs. 4, 5. Santa Barbara to Gulf of California.
 [Figures = *C. tumbezensis* (d'Orbigny).]

[non] *Pecten (Chlamys) prototranquebaricus paucicostatus* Vredenburg,
 1928, p. 433, pl. 15, fig. 14; = *P. prototranquebaricus noetlingi*
 Hertlein, 1936, p. 54.

Pecten (Chlamys) ?tumbezensis Orbigny. Dall, 1921, p. 19. Santa Barbara, California, to Peru. [Under "Section" *Leptopecten*. See paragraph 2 of *Remarks* under *C. latiaurata* (Conrad), this paper.]

Pecten tumbezensis d'Orbigny. Bosworth, 1922, p. 178. Pleistocene of NW Peru.

Chlamys sowerbyi (Reeve). Tomlin, 1928, p. 191.

Pecten cf. *latiauritus fucicolus* Dall. Li, 1930, p. 255, pl. 2, fig. 11. "Mouth of the Rio Grande near La Boca about one mile from mainland in Panama Bay. Recent." [= *Pecten tumbezensis* d'Orbigny, *fide* Pilsbry, 1932, p. 429.]

Pecten latiauritus Conrad *indentus* Li, 1930, p. 256, pl. 2, fig. 13. [Same data as above; = *Pecten tumbezensis* d'Orbigny, *fide* Pilsbry, 1932, p. 429.]

Pecten latiauritus Conrad *splendens* Li, 1930, p. 256, pl. 2, fig. 12. [Same data as above; = *Pecten tumbezensis* d'Orbigny, *fide* Pilsbry, 1932, p. 429.]

Pecten (Aequipecten) tumbezensis d'Orbigny. Grant & Gale, 1931, p. 206. "Gulf of California to Peru; ?Santa Barbara, California." [In synonymy: "*Pecten (Aequipecten) palmeri* Dall," Arnold, . . . , 1906." See reference in synonymy of *Chlamys (Leptopecten) palmeri* (Dall), this paper.]

Pecten (Leptopecten) tumbezensis d'Orbigny. Hertlein, 1935, p. 314, pl. 19, figs. 11, 12. Gulf of California to Tumbes and Paita, Peru.

Chlamys tumbeziensis [sic] d'Orbigny. Bavay, 1936, p. 307.

Aequipecten (Leptopecten) tumbezensis (Orbigny, 1846). Keen, 1958, p. 70, fig. 129.

Holotype: ?

Type locality: Tumbes, Peru.

Original description: Pect. testâ suborbiculari, depressiusculâ, subaequalvi, aequilaterali, auriculis inaequalibus, dextrâ majusculâ; valvarum alterâ radiatim costatâ, pallescente seu albâ, costis quatuordecim majoribus, rotundatis, laevibus, alterâ radiatim costatâ, costis quindecim acutioribus, fuscis, punctulis caerulescentibus aspersis, interstitiis tenuissimè transversim striatis, pallescentibus; long. 1.4, lat. 0.5, alt. 1.3 poll.

Additional description: Shell of moderate size, adult specimens averaging 32 mm in height. Both valves moderately convex; left one slightly shallower and often depressed between umbo and ventral margin. Beak closer to anterior of shell, resulting in anterior auricles and submargins of shorter length than posterior. Right valve with 14 or 15 rounded ribs and interspaces of same width; interspaces having fine

concentric lamellae in juvenile stage, smooth when adult; anterior auricle with 4 strong ridges covered with prominent concentric lamellae; posterior auricle with 4 to 6 ridges crossed by fine lamellae; byssal notch small and ctenolium having 3 or 4 teeth. Left valve with 14 or 15 usually rounded but occasionally triangular ribs; interspaces slightly wider and usually smooth, but occasionally having fine concentric lamellae. Right valve usually predominantly white, with tops of ribs colored in varying degree with darker or lighter shade of color of left valve. Left valve very dark gray-black, slate, blue-gray, red-brown, pale brown or orange, often mottled with white.

Geographical range: Gulf of California to Paita, Peru.

Geochronological range: Pleistocene; Recent.

Bathymetric range: From just below low tide to about 70 fathoms.

Ecological data: Usually found in mud, occasionally in sandy mud or sand.

Hancock Expeditions Collecting Stations:

ECUADOR: Manta Bay; 1 fathom, sand, sta. 402-35.

COSTA RICA: Salinas Bay; 8 fathoms, mud, sta. 476-35.

GUATEMALA: Off San Jose Point, 11 fathoms, black sand, sta. 770a-38; off San Jose Light, 12-13 fathoms, fine black sand, sta. 930-39.

GULF OF CALIFORNIA: South of Consag Rock (31° N); 30 fathoms, mud, bottom sample 2119.

Genus **SEMIPALLIUM** Jousseaume in Lamy 1928

Semipallium Jousseaume in Lamy, 1928, p. 169. Type species (by monotypy): *Pecten tigris* Lamarck, 1819, p. 171. Geographical range: South Pacific, from Tuamotu Archipelago westward; western Pacific, from New Guinea to southern Japan; East Indies; eastern portion of Indian Ocean.

Comptopallium Iredale, 1939, p. 359. Type species: *Comptopallium pauciplicatum* Iredale, 1939, p. 360 [= *Ostrea radula* Linné, 1758, p. 697]; type locality: Queensland. Geographical range: Indian Ocean, from Mauritius eastward; Western and Northern Australia, Queensland; East Indies; western Pacific, from New Guinea to southern Japan.

Complicachlamys Iredale, 1939, p. 362. Type species: *Complicachlamys wardiana* Iredale, 1939, p. 362, pl. 5, figs. 25, 25a; type locality: Queensland.

Bractechlamys Iredale, 1939, p. 366. Type species: *Bractechlamys evecta*

Iredale, 1939, p. 367, pl. 5, figs. 20, 20a [= *Pecten vexillum* Reeve, 1853, sp. 114, pl. 27, figs. 114a, b]; type locality: Queensland. Geographical range: Indian Ocean, from Mauritius eastward; East Indies; Queensland, Australia; Philippine Islands; south Pacific.

Original diagnosis: Le Dr. Jousseume range ce *P. tigris* dans un genre *Semipallium* caractérisé par des coquilles aplaties, allongées obliquement, inéquilatérales, à oreillettes très inégales.

Additional diagnosis: Shell higher than long and moderately to rather strongly oblique; right valve moderately convex, left valve flatter; margins occasionally compressed; hinge line more than $\frac{1}{2}$ but less than $\frac{3}{4}$ length of disk; ribs result of corrugations of disk; low radial ridges on ribs and in interspaces, with fine and very profuse concentric lamellae; anterior auricles longer than posterior and with shallow to moderately deep byssal notch; ctenolium usually present.

Remarks: The original diagnosis—shells flattish, obliquely elongate, inequilateral, with very unequal auricles—is brief, but the designation of *Pecten tigris* Lamarck as type species indicates the author's intention in proposing this genus.

Comptopallium and *Bractechlamys* were based on species here regarded as congeneric with *Semipallium tigris*. Both are also further examples of Iredale genera in which the diagnoses apply only to the type species. Geographic separation was the basis for his contention that the Australian representatives of such well-known species as *Ostrea radula* and *Pecten vexillum* were distinct and must be given new names. Actually, although both species are widely distributed, Australian specimens are inseparable from those found elsewhere. In concluding that the rib-count of *Ostrea radula* had geographic significance he was mistaken; the author has long series of that species from many localities throughout its range, the rib-count being not only inconstant, but 9- to 13-ribbed forms often occurring within a single population. In that respect *Pecten vexillum* is identical.

Several authors have referred both *Ostrea radula* and *Pecten vexillum* to *Decadopecten* Sowerby (1839, p. 37); however, the strong plicoid hinge which is the diagnostic feature of that genus is not found in *Semipallium*. Incidentally, according to Sherborn (1923, p. 1796) a typographical error explains Sowerby's proposal of the genus as *Decatopecten*; the error was corrected by Sowerby (1842b, p. 136). *Dentipecten* Gray (1847, p. 200) is a typonym of *Decadopecten*.

Complicachlamys is clearly a synonym of *Semipallium*. The type, *Complicachlamys wardiana*, is actually the Queensland subspecies of the

western and northern Australian *Pecten luculenta* Reeve (1853, sp. 59, pl. 16, fig. 59). Reeve described the latter in February of 1853, from Bathurst Island, North Australia; forgetting he had done so, in August of that year and in the same volume, he again described the shell as *Pecten Dringi* (sp. 152, pl. 33, figs. 152a, b), from "Bathurst Island, north-west coast of Australia."

In addition to the type species, the following are referable to *Semipallium*: the very widely distributed *radulum* (Linné), for which the range is given above, the southern Pacific *amicum* (E. A. Smith), *rapanensis* (Bavay) and *spiceri* (Rehder), the western Pacific and Indo-Pacific *vexillum* (Reeve), *oweni* (di Gregorio), *auriantiacum* (Adams & Reeve) and *fulvicostatum* (Adams & Reeve), the Queensland *luculentum wardianum* (Iredale), the Western and Northern Australian *luculentum* (Reeve), the Mauritius *crouchi* (E. A. Smith), and the western Atlantic *imbricatum* (Gmelin).

***Semipallium zeteki* (Hertlein) 1935**

(probably = *Semipallium vexillum* (Reeve) 1853)

Plate 41, figs. 1-2

Pecten digitatus Hinds, 1845, p. 61, pl. 17, fig. 2. "Inhab. Bay of Guayaquil [Ecuador]. In twenty-three fathoms, mud."

[?non] *Pecten digitatum* Perry, 1811, no. 2 on Explanation to pl. 55; pl. 55, fig. 2. "A native of Amboyna and the Eastern Seas."

[? =] *Pecten vexillum* Reeve, 1853, sp. 114, pl. 27, figs. 114a, 114b; "Hab.—?" [South, central and western Pacific; Indian Ocean.] = *P. distans* Lamarck. Reeve, 1853, sp. 49, pl. 13, fig. 49; "Hab. Philippine Islands; Cuming." (non *P. distans* Lamarck, 1819, p. 169; "Habité l'Océan atlantique." = *Ostrea glabra* Linné, 1758, p. 698. "In M. Mediterraneo.") = *P. Janus* Montrouzier in Fischer, 1858, p. 340; (New Caledonia). (non *P. janus* Münster in Goldfuss, 1833, p. 62, pl. 95, figs. 4a-4f; "Findet sich im tertiären Sande zu Baden bei Wien.")

Pecten digitatus Hinds. Dall, 1914, p. 122. ". . . is probably only a young specimen of *Pecten (Nodipecten) subnodosus* Sowerby."—Zetek, 1918, p. 52. [Listed among species *not* occurring in Panama.]

Chlamys (Pallium) digitatum Hinds. Bavay, 1936, p. 313.

Pecten (Chlamys) zeteki Hertlein, 1935, p. 306, pl. 19, fig. 9 [photocopy of Hinds' figure]. New name for *P. digitatus* Hinds, *non*

P. digitatum Perry. [Not listed by Zetek, as Hertlein said, among species probably occurring in Panama.]

Holotype: British Museum?

Type locality: Guayaquil, Ecuador.

Original description: Testâ subtrigonâ, planiusculâ, solidâ, aequi-auriculatâ, pallidâ, sanguineo transversim nubeculatâ; valvis consimilibus, costis novem rotundatis sulcatis; auriculis sulcatis; umbonibus subplanulatis, laevigatis; marginibus minutè denticulatis; intùs albâ.

Remarks: No species even remotely resembling Hinds' *Pecten digitatus* has ever been found in the eastern Pacific. In view of the known confusion as to the actual localities of a number of his species (see *Remarks* under *Chlamys hastata*, this paper), we can be almost certain that the holotype of *Pecten digitatus* was collected in the western Pacific during the voyage of the Samarang, and is actually a juvenile specimen of *Semipallium vexillum* (Reeve).

Perry's stylized and peculiarly colored figure is rather anomalous; if his holotype were located and found to be identical with Reeve's shell, *Pecten digitatum* Perry would have priority.

Subgenus **JUXTAMUSIUM** Iredale 1939

Juxtamusium Iredale, 1939, p. 368. [Proposed as a genus.] Type species: *Pecten maldivensis* E. A. Smith, 1906, p. 622, pl. 36, figs. 19-20 [= *Juxtamusium oblectatum* Iredale, 1939, p. 368, pl. 5, figs. 27-27a, designated type species by Iredale; type locality: Half mile W of North Direction Isle, Great Barrier Reef, 20 fathoms]; type locality: Maldiv Islands.

Original diagnosis (of *Juxtamusium oblectatum*; none given for the genus): Shell subcircular, thin, compressed, equi-valve, almost equi-lateral, gaping a little at the sides, ears large, unequal.

The surface is finely striate radially on the right valve, which is coloured, but completely overridden by very fine, closely-set, concentric striae; the left valve is uniformly pale and the radials are practically obsolete, while the concentric striae are microscopic. Internally the edge is closely ribbed, but the ribs do not extend far into the valve. Hinge folded, but striae missing, the ligamental groove triangular, but the ligament itself linear. The type from Station XVI measures 22.5 mm. in height and 22 mm. in breadth, the depth of the conjoined valves being only 6 mm.

Remarks: One of the major criteria Iredale gave for *Juxtamusium* was the presence of internal ribs. However, a paratype of *J. oblectatum* in the present author's collection has none, nor are any present on a specimen of *Pecten maldivensis* recently examined. The only possible explanation seems to be that under certain lighting conditions and at a certain distance from the shell the reverse surfaces of the external interspaces resemble ribs or lirae of the *Amusium* type; closer inspection reveals that appearance to be an illusion.

The most remarkable feature of the type species, a feature not found in any other known species of Pectinidae, is the nearly obsolete ctenolium below the anterior auricle of the left valve; while the right valve has a ctenolium of five or six normally prominent teeth, that of the left valve comprises three or four which are so weak as to be easily unnoticed unless the shell is carefully examined.

The other distinguishing criteria for this subgenus are the very thin shell, the large auricles, the very weak plicate ribbing and the simple hinge structure. On phylogenetic grounds these features seem to indicate *Semipallium* as the ancestral group. *Pecten natans* Philippi, although a good deal more inflated and with slightly stronger ribs of varying width, appears to be referable to *Juxtamusium*.

Iredale commented, "Smith . . . described a *Pecten maldivensis* which Hedley added to the Queensland list. Hedley's species is here described as new, and the characters are much nearer *Amusium* than of *Pecten*, and therefore a new generic name is proposed." Giving the Australian representative of Smith's species a new name was in accordance with Iredale's often-expressed contention that Australian mollusks cannot be conspecific with those living elsewhere, although he did, without explanation, violate that self-imposed rule, exceptions among the Pectinidae being the retention (under new genera) of *Ostrea pallium* Linné and *Pecten spectabilis* Reeve.

Hedley (1909, p. 423) was correct in referring the Queensland shell to *Pecten maldivensis*, and qualified his action by acknowledging, "I am indebted to Mr. C. J. Gabriel for identifying Hope Island specimens with the type in the British Museum." Incidentally, Australian specimens of *P. maldivensis* are about one-third larger than those reported from the Maldiv Islands, the Gulf of Oman and Mauritius.

The only known living representatives of this distinctive subgenus are *Pecten maldivensis* and *P. natans*.

Semipallium (Juxtamusium) natans (Philippi) 1845

Plate 42, figs. 1-2

Pecten vitreus King, 1831, p. 337. "Habitat in Fretto Magellanico (passim)."

[non] *Ostrea vitrea* Gmelin, 1791, p. 3328. "Habitat in Oceano septentrionali." ["Northern ocean."]

Pecten corneus G. B. Sowerby, 1842, p. 71, pl. 13, figs. 44, 45; pl. 20, figs. 244, 245. "Magellan."

[non] *Pecten corneus* J. Sowerby, 1818, p. 1, tab. 204. Fossil species.

Pecten natans Philippi, 1845, p. 57. "Patria: Fretum Magellanicum, Messier-Canal, Smith-Canal."

Pecten nasans [*lapsus calami*] Philippi. Reeve, 1853, sp. 113, pl. 27, fig. 113. "Straits of Magalhaens."

Pecten Jeffreysi de Gregorio, 1884b, p. 133. New name for *P. corneus* G. B. Sowerby.

Pseudamusium nasans A. Adams. Mabille & Rochebrune, 1891, p. H-126. "Baie Orange." [Orange Bay, Tierra del Fuego.]

Pseudamusium corneum A. Adams. Mabille & Rochebrune, 1891, p. H-126. "Detroit de Magellan."

Pseudamusium nasans Philippi. Dautzenberg, 1896, p. 65.

[?] *Pecten Thomasi* G. B. Sowerby, 1897, p. 138, pl. 11, fig. 2. Locality unknown to Sowerby. "= *P. corneus* adult," *fide* Melvill & Sykes, 1898, p. 46; = *P. corneus* G. B. Sowerby, *fide* Bavay, 1905, p. 29. Synonymy dubious; one reason: maximum height of *natans* (= *corneus*) about 35 mm, holotype of *Thomasi* (only specimen known) 65 mm.

Chlamys cornea G. B. Sowerby. Bavay, 1936, p. 307. In synonymy: "*natans* Philippi, *Thomasi* Sowerby." Footnote: "Reeve a déformé ce nom en nasans."

Pecten natans Philippi. Carcelles, 1950, p. 76. "Sur de Patagonica y Región magallánica."

Holotype: ?

Type locality: Strait of Magellan.

Original description: *P.* testa subaequivalvi, subaequilatera, ovata-orbiculari; costis planatis, in junioribus 25, in adultis circa 50, alternis minoribus; costis interstitiisque laevibus.

var. *a*) minor, tenuissima pellucida, 15''' alta, 13½''' lata, 4½''' crassa.

var. β) major, solidior, costis 50, 25''' alta, 23½''' lata, 8½''' crassa.

The coloring is varied; some are almost colorless, others yellowish with brown on the upper valve; others have a few yellow or brown ribs on a colorless background. [Translated from the German.]

Additional description: Shell rather small and nearly transparent; almost orbicular (slightly higher than long); adult specimens averaging 30 mm in height; both valves moderately to rather deeply convex and frequently slightly oblique; hinge line about $\frac{3}{4}$ length of disk. Ribs of both valves result of corrugations of disks and number ranging from 30 to 50; width and height irregularly varying and divarication frequent; occasionally higher and narrower on left valve than on right. Auricles very unequal, anterior nearly twice as long as posterior. Right valve appearing completely smooth, but having very minute oblique striae along submargins; anterior auricle with fine concentric striae and 3 to 5 distinct rounded folds separated from disk by broad fasciole; ctenolium of 5 teeth; posterior auricle with several faint ridges, very minute horizontal striae and fine vertical growth ridges. Left valve with ribs smooth but interspaces distinctly concentrically lamellose; anterior auricle covered with fairly strong concentric striae and having 5 to 7 distinct radiating ridges; posterior auricle with 4 or 5 faint ridges, minute horizontal striae and stronger concentric striae. Coloring as indicated by Philippi.

Remarks: This species is quite distinct; it resembles, in some respects, only one other species of Pectinidae: *Juxtamusium maldivensis* (E. A. Smith).

In referring *Pecten natans* to *Juxtamusium* the author followed the suggestion of F. K. North, whose unpublished classification is cited in the preface to this paper. Neither *Pseudamussium* nor *Chlamys* are logical choices; *Leptopecten* was considered, but the size and shape of the auricles of *Pecten natans* prohibit its inclusion in that subgenus. For the present, *Juxtamusium* seems most appropriate.

Geographical range: eastern Pacific: southern portion of Magallanes Province, Chile, and western portion of Tierra del Fuego Territory (Chile); western Atlantic: eastern portion of Tierra del Fuego Territory (Argentina).

Geochronological range: Available records indicate Recent only.

Bathymetric range: No records located; probably only in shallow water.

Ecological data: King (1831, p. 337) commented, "This shell is found attached to the leaves of the *Fucus giganteus*, and with other *Mollusca*, is the food of the Steamer or Race-horse Duck (*Micropterus brachyptera* and *M. Patagonica*).” Philippi, after his description of this species, observed that it was abundant among "great masses of giant seaweed," either swimming about or attached, and seemed only to occur in places "where the sea cannot possibly become turbulent."

Genus **NODIPECTEN** Dall 1898

Nodipecten Dall, 1898, p. 695. [Proposed as a section of *Chlamys*.]

Type species: *Ostrea nodosa* Linné, 1758, p. 697. [Synonyms: *Pecten corallinus* Chemnitz, 1784, p. 306, pl. 64, figs. 609-611; *Ostrea decemradiata* Gmelin, 1791, p. 3329; *Pecten fragosus* Conrad, 1849, p. 214, pl. 39, fig. 11; *Pecten pernodosus* Heilprin, 1887, p. 131, pl. 16b, figs. 69, 69a (Pliocene of Florida); *Pecten (Lyropecten) pittieri* Dall, 1912, p. 10 (Pleistocene of Costa Rica)]; type locality: "Habitat in O. Africano & Indico." Geographical range: western Atlantic, from North Carolina to Brazil (about 15° south, possibly farther); Caribbean Sea and Gulf of Mexico. Also reported from Canary Islands, west Africa and Mauritius, but records very doubtful.

Original diagnosis: Shell like *Lyropecten*, but the ribs intermittently nodose, with more or less prominent hollow nodes or bullae; radial striation pronounced; ears unequal, the posterior smaller, the valves often more or less oblique; imbricate surface layer sometimes very marked.

Additional diagnosis: Shell nearly equivalve, flatly to rather deeply convex, slightly higher than long, and often moderately to sharply compressed at ventral margin; anterior auricles longer than posterior and with prominent radial ridges; byssus sinus moderately deep. Ribs strong, with pronounced radial ridges and nodules, latter usually larger on left valve and often present only on alternate ribs; disk and auricles moderately to profusely imbricated. Hinge dentition strong, diagonal linear crura adjoining provinculum usually being quite prominent.

Remarks: The locality Linné gave for the type species is obviously incorrect. North (see Preface) examined the Pectinidae in Linné's cabinet (Linnean Society, Burlington House, London), and said that although the locality may indicate that he was referring to the shell now known as *Nodipecten corallinoides* (d'Orbigny), Drawer 8 contains two left valves of typical *N. nodosus*.

Assigning generic rank to *Nodipecten* seems advisable to the present author. North did so, as did Rehder (1938, in Dall, Bartsch & Rehder, p. 85). Other authors have regarded the unit as either a subgenus of *Chlamys* or *Lyropecten*, or a synonym of the latter. The type species of *Lyropecten*, *Pallium estrellanum* Conrad (1857b, p. 313), is quite distinct from any of the forms Dall mentioned in connection with *Nodipecten* and certainly not congeneric.

Dall's unit was poorly defined, nodosity being practically the only distinguishing feature. The additional diagnosis given above includes additional criteria which indicate more comprehensively what his intentions seem to have been in proposing the unit.

In addition to the type species, the following are also referable to *Nodipecten*: *subnodosus* and *magnificus* Sowerby (eastern Pacific); *langfordi* Dall, Bartsch & Rehder (Hawaii); *noduliferus* Sowerby (east Africa, Mauritius and Reunion); *corallinoides* d'Orbigny (Spanish Morocco; islands off west Africa, from the Azores to St. Helena, and possibly also a portion of the mainland, although no records located).

KEY TO THE EASTERN PACIFIC SPECIES OF *Nodipecten*

1. Right valve with 10-11 ribs, left with 9-10
 *subnodosus* (Sowerby)
 (Western Lower California, Mexico; Scammon Lagoon to Cape
 San Lucas; Gulf of California to Negritos, Peru)
1. Right valve with 12-14 ribs, left with 13-15
 *magnificus* (Sowerby)
 (Galapagos Islands)

Nodipecten subnodosus (Sowerby) 1835

Plate 43

Pecten subnodosus Sowerby, 1835, p. 109. "Variat α , colore rufo-fuscescente, striis albis. Hab. ad Sinum Californiae [Gulf of California]. β , coloribus subvariegatis pictâ seu fuscâ, maculis albis utplurimum notatâ. Hab. ad Insulam Platae, Columbiae Occidentalis [La Plata Island, Ecuador]. γ , testâ depressiore, colore aurantiaco nitente. Hab. ad Sinum Tehuantepec, Mexicanorum [Gulf of Tehuantepec, west Mexico]. Found in sandy mud and coral sand in from ten to seventeen fathoms."—Sowerby, 1842, p. 65, pl. 15, figs. 97, 112. "Var. 1. Brownish red with white striae, from California. Var. 2. Variegated with brown and white patches, from Isl. Plata, East Columbia [*lapsus calami*; West "Columbia"]. Var. 3. A more depressed shell, of a bright orange colour, from Tehuantepec Bay, Mexico."

- Pecten (Dentipecten) subnodosus* Sow. Mörch, 1861, p. 210. San Jose Nicoya Gulf, Costa Rica.
- Lyropecten intermedius* Conrad, 1867, p. 7. "Cape St. Lucas, California." Lower California, Mexico.
- Pecten subnodosus* Gray. Stearns, 1891, p. 308. Manta, Ecuador. ["Gray" a *lapsus calami* for Sowerby.]
- [non] *Pecten subnodosus* Sby. Stearns, 1893, p. 372. "James Island [Galapagos Islands]. The examples are from 1¾ to 2 inches high and have twelve to fourteen ribs." [= *Nodiopecten magnificus* (Sowerby).]
- Lyropecten subnodosus* (Sowerby). Verrill, 1897, p. 64. ". . . tropical regions of the Pacific coast of America."
- Pecten (Nodiopecten) subnodosus* Sowerby. Dall, 1898, p. 710. [*Pecten intermedius* Conrad in synonymy.] "Pleistocene of Cerros [now Cedros] Island and other points on the Lower California coast. Living in the adjacent waters."—Dall, *ibid.*, p. 729. ". . . on the Pacific shores of middle America."—Arnold, 1906, p. 128, pl. 52, fig. 1; pl. 53, figs. 1, 1a. [*Pecten intermedius* Conrad in synonymy.] Pliocene: Temescal Canyon, Santa Monica Mountains, Los Angeles County, California. Pleistocene: San Pedro; Cerros Island, etc. "Living: Coast of Lower California to Ecuador and the tropical shores of South America (Carpenter)."
- Pecten subnodosus* Sowerby. Dall, 1909, p. 256. Gulf of California to Guayaquil and the Galapagos Islands.—Olsson, 1924, p. 127. "Negritos, Mancora [Peru]; Salinas [Ecuador]."
- Chlamys (Lyropecten) subnodosa* Sowerby. Lamy, 1909, p. 212. "Basse Californie."
- Chlamys (Lyropecten) subnodosus* (Sow.). Tomlin, 1928, p. 191.
- Pecten (Nodiopecten) [lapsus calami] subnodosus* Sowerby. Boone, 1928, p. 7.
- Pecten (Lyropecten) nodosus* (Linnaeus) variety *subnodosus* Sowerby. Grant & Gale, 1931, p. 180. Panama and West Colombia.
- Pecten (Lyropecten) nodosus* (Linnaeus) variety *intermedius* (Conrad). Grant & Gale, 1931, p. 181. "Scammons Lagoon, Lower California, to the mainland of Mexico. Also reported south to Ecuador (Jordan)."
- Pecten (Lyropecten) subnodosus* Sowerby. Hertlein, 1935, p. 317, pl. 19, fig. 15. [*Lyropecten intermedius* Conrad in synonymy.] "Scammon Lagoon, Lower California, and the Gulf of California, to Guayaquil, Ecuador (Dall and others). Also Pliocene and Pleistocene

of Lower California and Pliocene of Imperial County, California." —Hertlein & Strong, 1946, p. 58. Tres Marias Islands, Mexico, to Negritos, Peru.

Chlamys (Nodipecten) subnodosus (Sowerby). Bavay, 1936, p. 312.

Pecten nodosus intermedius [typ. err.; *intermedius*] Conrad. M. Smith, 1944, p. 52. "Scammon's Lagoon, Lower California; Cape San Lucas (type locality); Ecuador."

Pecten nodosus subnodosus Sowerby. M. Smith, 1944, p. 52, fig. 692D. "Gulf of Tehuantepec [typ. err.; Tehuantepec], in 10-17 fathoms; near Cocos Island, in 66 fathoms. . . . *Pecten digitatus* Hinds (probably a young example)." [*P. digitatus* Hinds = *Semipallium zeteki* (Hertlein); see that species, this paper.]

Pecten (Lyropecten) subnodosus intermedius Conrad. Hertlein & Strong, 1946, p. 58. "Scammon Lagoon to Cape San Lucas, and the Gulf of California; Clarion Island [Revilla Gigedo Islands, west Mexico]."

Lyropecten (Lyropecten) subnodosus (Sowerby, 1835). Keen, 1958, p. 74, fig. 137.

Holotype: British Museum.

Type locality: La Plata Island, Ecuador.

Original description: Pect. testâ subaequalvi, aequilaterali, auriculis inaequalibus; striis radiantibus numerosissimis, radiisque decem, crassis, rotundatis, alternatim nodoso-vesicularibus vel subnodosis; intus plerumque purpureo signatâ; long. 5.25, lat. 2.75, alt. 5. poll.

Additional description: Shell large and thick, averaging 130 mm in height when adult, and usually longer than high; left valve usually more concave than right; hinge line from almost half to slightly more than half length of disk. Right valve often concentrically undulated; 10 ribs (occasionally 11), those next to submargins being almost obsolete; ribs rounded and with 7 to 15 thin radial ridges; interspaces with 5 to 8 ridges of same size; fine concentric imbricating lamellae between all ridges. Anterior auricle short for size of disk, of varying height, and concentrically lamellose; from 8 to 12 radiating riblets, those next to disk being much smaller; byssal notch rather shallow and either rounded or angled; ctenolium of 5 to 10 teeth in young shells, later only 3 or 4 obscurely present. Posterior auricle shorter, also lamellose, and with 10 to 18 radial riblets. Left valve often concentrically undulated; usually 9 but occasionally 10 ribs, those next to submargin being almost obsolete; ribs rounded and having 8 to 16 thin radial ridges; central rib and alternate one or two either side often having hollow nodules, with

degree of prominence varying in individuals; interspaces with 6 to 8 radial ridges; entire disk profusely covered with fine imbricating lamellae which is nearly always worn off tops of ribs on mature specimens. Anterior auricle concentrically lamellose and with 10 to 15 radial ridges of varying size; byssal sinus shallow. Posterior auricle same as that of right valve. Hinge line with strong diagonal crura adjoining resilial pit. Color range red-brown, red, red-orange, orange, yellow-orange or yellow, with parts of shell white. Right valve usually predominantly white, most of coloring occurring on ribs and auricles; left valve of darker and more evenly distributed color; ridges of disk and auricles on each valve either white or of paler color; darker and/or lighter bands of color on both valves. Interior red-brown, purple-brown or violet around auricles and margins; heavy white callus covering umbonal area, surrounding muscle scar, and reaching to from one-third to two-thirds of distance to ventral margin.

Remarks: Specimens from western Lower California and the Gulf of California to southern West Mexico are usually larger at maturity, lighter in color, and with 10 ribs on the right valve and 9 on the left, while those from central West Mexico (overlapping the above) to Peru are usually smaller, darker, and with 11 ribs on the right valve and 10 on the left. Conrad's *Pecten intermedius* was based on the northern "form"; he commented, "It differs from *subnodosus* . . . in having much finer striae, numbering nearly double as many between each rib." The finer striae are actually found only on occasional specimens, and the features of the northern "form" mentioned above would not be of specific or infraspecific significance even if they were constant.

Variety β of Sowerby's *Pecten magnificus* was almost certainly a specimen of *Nodipecten subnodosus*; its type locality, La Plata Island, Ecuador, is the same, and only *N. subnodosus* has been subsequently recorded from that area. Apparently *N. magnificus* is restricted to the Galapagos Islands, while *N. subnodosus* has not been found there.

Of this species Dall said, "There seems to be little reason for separating this form from the *P. nodosus* of the Antilles. Both vary through a strictly analogous series of mutations." (1898, p. 710.) A recent concurrence with that view was expressed by Dodge, who commented, "It seems to be an ecological and evolutionary form of *nodosus* and suggests a migration of that species in Miocene times by an ocean passage through what is now Central America." (1952, p. 172.) The important point in Dall's remarks is that the "series of mutations" by which the species vary are "strictly analogous"; an analogue, by defini-

tion, is not an object *identical* with another, and, although *Nodipecten subnodosus* is recognized as the eastern Pacific analogue of *N. nodosus*, there are important and easily seen differences between them. As for Dodge's opinion, even if conclusive evidence of migration could be shown, *N. subnodosus* is sufficiently restricted ecologically and stabilized morphologically to be regarded as a distinct species.

Geographical range: Western Lower California: Scammon Lagoon to Cape San Lucas. Gulf of California to Negritos, Peru.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Recorded from low tide to 60 fathoms.

Ecological data: Found in shallow depressions in sand at low tide; in deeper water on rock, sand or mud bottoms, associated with red algae, nullipores, coralline and coral; vermetids, bryozoans and barnacles often commensal.

Hancock Expeditions Collecting Stations:

PANAMA: Secas Islands; 14 fathoms, nullipores, sta. 450-35.

CLARION ISLAND, REVILLA GIGEDO ISLANDS, MEXICO:
32-57 fathoms, nullipores, sta. 136-34, 137-34.

GULF OF CALIFORNIA: 13 stations; 2-60 fathoms, rock, sand, mud, coralline, algae, nullipores.

WESTERN LOWER CALIFORNIA: 24-25 fathoms, gray-green sand, sta. 1261-41d2.

***Nodipecten magnificus* (Sowerby) 1835**

Plate 44

Pecten magnificus Sowerby, 1835, p. 109. "ad Insula Gallapagos . . . in coral sand at a depth of six fathoms." ["Variat α "; bright red.] "ad Insulam Platae, Columbiae Occidentalis [La Plata Island, Ecuador] . . . in coral sand in seventeen fathoms." ["Variat β "; brown, variegated with white patches.]—Sowerby, 1842, p. 65, pl. 15, fig. 114. "The colour is bright red. Mr. Cuming's collection. East Columbia." [*lapsus calami*; West "Columbia."]

[non] *Pecten magnificus* Gabb, 1873, p. 256. Santo Domingo District, Dominican Republic, West Indies. "Oligocene of St. Domingo." [= *Pecten nodosus* Linné, *fide* Dall, 1898, p. 717.]

[non] *Pecten subnodosus* Sby. Stearns, 1893, p. 372. "James Island Galapagos . . . The examples are from 1¾ to 2 inches high and have twelve to fourteen ribs." [= *P. magnificus*.]

Pecten magnificus Sowb. Pilsbry & Vanatta, 1902, p. 550. "Tagus Cove [Albemarle Island, Galapagos Is.] and Narbro [Narborough Island, Galapagos], opposite Tagus Cove."

Pecten magnificus Sowerby. Dall, 1909, p. 289. "*P. subnodosus* var." *Pecten* (*Lyropecten*) *magnificus* Sowerby. Grant & Gale, 1931, p. 182, pl. 9, fig. 1; pl. 10, fig. 6. Galapagos Islands.—Hertlein & Strong, 1939, p. 369. Late Pleistocene of James Island, Galapagos.

Holotype: British Museum.

Type locality: Galapagos Islands.

Original description: Pect. testâ subaequalvi, aequilaterali, auriculis inaequalibus; striis radiantibus exiguis numerosissimis, radiisque tredecim, crassiusculis, rotundatis, nonnunquam subnodosis; intus albâ purpureo marginatâ; long. 5.5, lat. 2., alt. 5.5 poll.

Remarks: The author examined one complete specimen and one left valve in the Stanford University collection, and five valves on loan from the U.S. National Museum. Apparently *Nodipecten magnificus* differs from *N. subnodosus* only in the greater number of ribs (12 to 14 on the right valve, 13 to 15 on the left) and in a reversal of their quantity, the left valve having one more rather than the right. Those criteria would seem to entitle *N. magnificus* to only subspecific rank, but the species is known by so few specimens that a change in its status seems inadvisable at present.

Sowerby's variety β was probably a specimen of *N. subnodosus*; see *Remarks* under that species.

Geographical range: Galapagos Islands. (Ecuador doubtful.)

Geochronological range: Pleistocene, Recent.

Bathymetric range: No data available.

Ecological data: None available.

Genus **HINNITES** Defrance 1821

Hinnites Defrance, 1821, p. 169. Type species: *Ostrea crispa* Brocchi, 1814, p. 567 [= *Hinnites cortesyi* Defrance, 1821, p. 169; Atlas, pl. 38, figs. 1, 1a; designated type species by Defrance]; type locality: Pliocene of Placentino and Asti, north Italy.

Hinnita Ferussac, 1822, p. xl. [Invalid emendation of *Hinnites* Defrance.] Type species: *Lima gigantea* Gray, 1825, p. 139 [designated type species (as *Hinnites giganteus*) by Gray, 1826, p. 103; *non Plagiostoma* (= *Lima*) *gigantea* J. Sowerby, 1812, p. 176, pl. 77 (Jurassic); *Hinnites giganteus* renamed *Pecten* (*Chlamys*) *multirugosus* by Gale, 1928, p. 92]; type locality: Straits of Juan de Fuca, between SW end Vancouver Island, Canada, and Washington, USA.

Hinnus Gray, 1826, p. 362. [Invalid emendation of *Hinnites* DeFrance.]
Hynnites Herrmannsen, 1847, p. 547. [Invalid emendation of *Hinnites* DeFrance.]

Original diagnosis: Coquille bivalve, inéquivalve, adhérente, auriculée, hérissée ou rude; à valve inférieure, couverte de cercles concentriques; à valve supérieure, rayonnée longitudinalement; à fossette profonde pour le ligament; impression musculaire placée du côté opposé à celle des huitres.

Additional diagnosis: Juvenile shell of *Chlamys* form, moderately convex, slightly higher than long, and with numerous small and usually spinose ribs. Shell attaching to foreign object (during adolescence) by right valve, that valve then becoming more convex, distorted in outline, irregularly compressed at margins and coarsely sculptured; left valve becoming distorted to match right, but seldom increasing greatly in convexity and with sculpture less coarse; original outline of anterior auricle of right valve often obliterated by surrounding deposit of shell.

Remarks: This genus includes only six known living species. In the western Atlantic and Mediterranean it is represented by *pusio* (Linné) (= *Pecten distortus* da Costa, *Ostrea miniata* Born, *O. sinuosa* Gmelin, *O. multistriata* Poli, *P. Isabellae* Macgillivray, *P. spinosus* Brown, *Hinnites irregularis* Deshayes). *Hinnites absconditus* P. Fischer in Locard has been reported only from the Cape Verde Islands and Sierra Leone, west Africa. The West Indies species is *adamsi* (Dall), known only by a left valve found off St. Vincent, Windward Islands. In the eastern Pacific *multirugosus* (Gale) ranges from the Aleutian Islands to Lower California. The southeast Pacific *pasca* (Dall), reported only from Easter Island, is known by six single valves; the holotype, a left valve, is in the U.S. National Museum; another left valve is in the California Academy of Sciences, San Francisco; the author's collection contains the only right valve known (collected in 1956) and three left valves, one collected in 1953 and two in 1956. Sowerby's *corallinus* is native to east Africa and has recently been reported from the Bonin Islands, Japan.

***Hinnites multirugosus* (Gale) 1928**

Plates 45-49

Lima gigantea Gray, 1825, p. 139.

[non] *Plagiostoma gigantea* J. Sowerby, 1814, p. 176, pl. 77. [Jurassic. *Plagiostoma* proposed as section of *Lima* by J. Sowerby, 1814, p. 175; Gray's *Lima gigantea* thus preoccupied.]

- Hinnita giganteus* Gray, 1826, p. 103. [*Lima gigantea* Gray emended to *Hinnita giganteus* and designated type-species of *Hinnita* Ferussac, 1822.]
- Hinnites giganteus* Gray. G. B. Sowerby, 1828, p. 70.
- [non] *Pecten giganteus* Münster in Goldfuss, 1833, p. 48, pl. 90, fig. 14. "E montibus Bavaricis." [Mesozoic of Bavaria, Germany.]
- Hinnita Poulsoni* Conrad, 1834, p. 182, pl. 14. "The habitat is unknown to me."
- [non] *Pecten Poulsoni* Morton, 1834, p. 59, pl. 19, fig. 2. Cretaceous, near Claiborne, Alabama.
- [?] *Pecten comatus* Valenciennes, 1846, pl. 18, fig. 2. [Carpenter (1864, p. 528) commented, "May be = *hastatus*, jun., but. although figured without the red spot, it most resembles *Hin. giganteus*, jun."]
- [non] *Pecten comatus* Münster in Goldfuss, 1833, p. 50, pl. 91, figs. 5a, 5b, 5c. "E montibus Westphalicis." [Jurassic of Westphalia, Germany.]
- [non] *Pecten rubidus* Hinds. Middendorff, 1849, p. 528, pl. 13, figs. 4-6. [= *Hinnites multirugosus* (Gale).]
- Hinnites giganteus* Gray. Reeve, 1853 [October], sp. 2, pl. 1, fig. 3. "Hab. California and the Straits of Juan Fernandez." [*lapsus calami*; Straits of Juan de Fuca.]—Keep, 1888, p. 165, fig. 138. "It is most abundant in northern waters."
- Pecten* (*Hinnites*) *giganteus* Gray. Kobelt, 1888, p. 252, pl. 66, figs. 1-3.—Arnold, 1903, p. 115. Pliocene: Santa Rosa Island, Ventura County; Los Angeles County. Pleistocene: Santa Barbara to San Diego; Living: "Strait of Fuca" to San Diego.
- [non] *Pecten* (*Hinnites*) *giganteus* Gray. Eldridge & Arnold, 1907, p. 17, pl. 32, fig. 1. [= *Spondylus perrini* Wiedey, 1928, p. 138, pl. 17, figs. 6, 7. Lower Miocene of Ventura County, California.]
- Hinnites giganteus* Gray. Dall, 1921, p. 20. Aleutian Islands to Magdalena Bay, Lower California.
- Pecten* (*Chlamys*) *multirugosus* Gale, 1928, p. 92. New name for *Hinnita gigantea* Gray.
- Pecten* (*Pecten*) *multirugosus* Gale. Grant & Gale, 1931, p. 159, pl. 11, figs. 5a, 5b. Pliocene records from Santa Barbara, Ventura, Los Angeles and Imperial Counties, California. Pleistocene: Marin County and Santa Barbara to San Diego, California. Recent range same as Dall, 1921.

Hinnites multirugosus Gale. Fitch, 1953, p. 41, fig. 7. "Queen Charlotte Islands, British Columbia, to Abrejos Point, Baja California."—Abbott, 1954, p. 369. Aleutian Islands to Lower California.

Holotype: British Museum.

Type locality: Juan de Fuca Strait (between Vancouver Island, British Columbia, Canada, and the state of Washington, U.S.A.).

Original description: Testa crassa, ponderosa, subauriculata. Albido-rosea, irregulariter radiata costata striata; intus alba, rufo maculata. Lat. 15-4, long. 18-4 unc.

Additional description: Shell large, heavy, and irregular in outline when adult; averaging 105 to 150 mm in height, occasionally much larger; ratio of height to length variable, but almost always higher than long.

Juvenile form (up to from 20 to 30 mm in height): identical with *Chlamys*; slightly higher than long; valves of nearly equal convexity; hinge line from $\frac{2}{3}$ to $\frac{3}{4}$ length of disk. Right valve with numerous low and finely imbricated ribs, which become dichotomous early and appear to be paired, particularly near ventral margin; specimens up to about 15 mm in height have distinct intercostal concentric lamellae, which disappear soon thereafter. Anterior auricle long, often produced as far as anterior margin of disk; 6 to 11 concentrically lamellated radial riblets; deep byssal notch and ctenolium of 5 teeth. Posterior auricle $\frac{1}{3}$ to $\frac{1}{2}$ length of anterior and with faint, oblique, imbricated radial riblets. Left valve with 10 or 11 ribs, moderately to prominently spinose; between them 3 to 5 imbricated riblets, with either center one of three or second and fourth of five slightly larger. Anterior auricle large, with 12 to 20 imbricated radial riblets of irregular size; byssal sinus usually shallow; posterior auricle same as that of right valve. Color range including deep to pale brown, red-orange, orange and yellow; left valve often mottled or streaked with darker and lighter colors; right valve either much lighter than left or white; purple-red stain appearing around resilial pit when shell reaches 10 to 15 mm in height.

Adult form: large, heavy and irregular; juvenile *Chlamys* stage preserved intact on each valve, succeeding growth being much heavier and coarser. Shell attached by right valve to rock (or other foreign object), by means of shell substance secreted by outer lobe of mantle of that valve; moderately to greatly distorted (both laterally and horizontally) as result of conformation to surface of fixed object and, in many cases, restriction of space in which to grow. Right valve quite

convex, with adult ribs (below *Chlamys* stage) straight or irregularly waved and moderately to heavily imbricated; ribs actually low ridges on outer surface of valve, no trace of them being visible from interior. Auricles usually having margins obliterated by surrounding shell deposit; no ctenolium. Left valve flattish and usually slightly smaller than right; structure of ribs and auricles same as on right valve. Hinge line straight when growth of shell not hampered; when growth is restricted (as in narrow rock crevices), new hinge lines are formed successively lower so valves can continue to open; in such cases hinge line tapers downward on each side of ligament, more so posteriorly. Color range deep brown to pale brown, the right valve lighter; interior white, occasionally with large and irregular dark-brown central area and often brown along ventral margin; large purple stain on hinge area.

Remarks: In the juvenile stage this species is quite constant. Adolescent and adult specimens vary greatly in convexity and outline, but are always easily recognizable. Very young specimens bear a strong resemblance to *Chlamys hastata* (Sowerby); for the distinguishing features see *Remarks* under that species.

Geographical range: Aleutian Islands to Magdalena Bay, Lower California, Mexico. Also reported from Guadalupe Island, Mexico, 180 miles west of central Lower California.

Geochronological range: ?Miocene, Pliocene, Pleistocene, Recent.

Bathymetric range: Low tide to 30 fathoms, possibly deeper.

Ecological data: Free-swimming juveniles often found on gravel bottoms; byssal attachment to a fixed object occurs when shell is anywhere from 15 to 25 mm. high, cementation beginning soon thereafter; one or more of the following are often commensal on the left valve of adult specimens: hydroids, "worm tubes," barnacles, bryozoa, boring sponges.

Hancock Expeditions Collecting Stations:

SOUTHERN CALIFORNIA and SANTA BARBARA ISLANDS:

63 stations; shore to 20 fms.

WESTERN LOWER CALIFORNIA: 9 stations; 2-30 fms.

Genus **PECTEN** Müller 1776

Pecten Müller, 1776, pp. xxxi, 248. Type species: *Ostrea maxima* Linné, 1758, p. 696; type locality: "Habitat in Oceano Europaeo." [First valid designation as type species: Schmidt, 1818, p. 67.]
Geographical range: Andoy Island, Norway, to northwest Africa in Atlantic; Spanish Morocco and Algeria in Mediterranean.

- [*non*] *Pecten* Osbeck, 1757, p. 299; 1765, p. 391; 1771, p. 100. [*nomen dubium*; only description (Osbeck, 1771, p. 100): "... a red shell ... which on its valves represented many branches." Holotype lost; almost certainly not a species of Pectinidae. Genus erroneously dated from Osbeck by Sherborn, 1929; Grant & Gale, 1931; Thiele, 1934; Shimer & Shrock, 1944; Gilbert, 1945.] Type species (by monotypy): *Pecten adscensionis* Osbeck, 1765, p. 391; type locality: Cross Bay, Ascension Island, south Atlantic, in 24 fathoms.
- Pandora* Megerle von Mühlfeld, 1811, p. 59. [*non*] *Pandora* Hwass in Chemnitz, 1795, p. 211, pl. 199, figs. 1947, 1948 (Pandoridae); [*non*] *Pandora* Bruguiere, 1797, pl. 250 (Pandoridae). Type species: *Ostrea maxima* Linné, 1758, p. 696.
- Janira* Schumacher, 1817, pp. 40, 117, 118. [*non*] *Janira* Leach, 1814, p. 434 (Crustacea); [*non*] *Janira* Oken, 1815, p. 132 (Ctenophora); [*non*] *Janira* Risso, 1816, p. 175 (Crustacea). Type species: *Janira intermedia* Schumacher, 1817, p. 118, pl. 3, fig. 4 [= *Ostrea maxima* Linné, 1758].
- Vola* H. & A. Adams, 1858, p. 554 (*ex* Klein, 1753, p. 135, pl. 9, fig. 53; pre-Linnean). [*non*] *Vola* Mulsant, 1850, p. 377 (Coleoptera); *non* *Vola* Mörch, 1853, p. 59 (invalid publication: sales catalogue; see under genus *Pseudamussium*). Type species: *Ostrea jacobaea* Linné, 1758, p. 696; type locality: Mediterranean Sea.
- Philippia* von Teppner, 1922, p. 221. [*non*] *Philippia* Gray, 1847, p. 146 (Architectonicidae); [*non*] *Philippia* Weber, 1915, p. 111 (Hirudinea). Type species: *Ostrea arcuata* Brocchi, 1814, p. 578, pl. 14, fig. 11; type locality: Oligocene of Rocchetta Cairo, Savona, Liguria, Italy.
- Deperctia* von Teppner, 1922, p. 259. [Proposed as a subgenus of *Philippia* von Teppner.] Type species: *Pecten cristatocostatus* Sacco, 1897b, p. 64, pl. 21, figs. 1-7; type locality: Miocene of Turin, Italy.
- Heritschia* von Teppner, 1922, p. 264. [Proposed as a subgenus of *Philippia* von Teppner.] Type species: *Pecten aduncus* Eichwald, 1830, p. 213; type locality: Miocene of Zukowçe, Volhynia, NW Ukraine, Russia.
- Jaworskia* von Teppner, 1922, p. 266. [Proposed as a subgenus of *Philippia* von Teppner.] Type species: *Pecten grandis* J. de C. Sowerby, 1828, p. 163, pl. 585; type locality: Pliocene of Suffolk Crag, England.

[Synonymy of preceding four subgenera proposed by von Teppner suggested by F. K. North.]

Notovola Finlay, 1926, p. 451. Type species: *Pecten Novae-Zelandiae* Reeve, 1852, sp. 36, pl. 8, fig. 36; type locality: "New Zealand."

Original diagnosis: Branchiis cirratis pede juxta auriculam; card. fossula ovata, byssum emittens.

Additional diagnosis: Shell equilateral or nearly so; right valve moderately convex and left flattish or slightly inflated; auricles rather large and nearly equal, convex on right valve and convex on left; byssal notch small; ribs strong, usually rounded but occasionally squarish; radial ridges or striations often on and/or between ribs, also fine concentric lamellae, usually more prominent on left valve.

Remarks: Most contemporary systematists reject Osbeck as the author of *Pecten*. Winckworth (1934) presented a summation of the matter so thorough and definitive as to deserve quotation in its entirety:

"Grant and Gale, in a book which contains a great deal of valuable systematic work, seem to me to be in error when they regard the genus *Pecten* as established by Osbeck instead of Müller. Osbeck's account of his eastern travels was originally published in Swedish in 1757, and is too early to be taken into account; this was translated into German in 1765, and an English edition, translated from the German, appeared in 1771. The only reference to *Pecten* faithfully survives both translations, as may be seen from the complete quotations here given.

1757, p. 299. "Med ankartåget sölade et hwitt Corall-ämne, hwarpå en röd Snäcka, *Pecten adscensionis*, som hade många grenar på skalet och war fastväxt."

1771, p. 100. "With the cable we pulled up a piece of coral, on which a red shell (*Pecten Adscensionis*) was growing, which on its valves represented many branches."

"While it is true that the German edition had been carefully revised, this does not give nomenclatorial validity to the original names. Opinion 21 of the International Commission on Zoological Nomenclature refuses nomenclatorial status to Klein's genera of 1744 as quoted by Walbaum in 1792. Opinion 57 is even more pertinent: "Hasselquist's 'Iter Palaestinum' was published prior to 1758; it was edited as to its nomenclature by Linnaeus. The Ger-

man translation by Gadebusch, published in 1762, does not give validity to the names published in the original edition in 1757."

"Not only is *Pecten* Osbeck inadmissible on this basis, but it would also appear to be a *nomen nudum*. The genus is in no way described, but is solely dependent on its association with the specific name *Adscensionis*. This species, however, is certainly not indicated or defined, and surely one cannot regard this casual allusion as a description. It is so far from being described that Grant and Gale interpret it as an unidentified species of *Chlamys*, while I should consider it more probable that it was *Spondylus powelli* Smith, after consulting published and manuscript lists of Ascension Island mollusca and bearing in mind the remark, firmly grown (fastwaxt) on coral; though an unknown species of *Chama* might be a better guess. This point could be settled from the actual specimen, which is probably still in existence, but "in no case is the word indication to be construed as including museum specimens." [Opinion 1.]

"My conclusion is that *Pecten* Osbeck is a nude name, published in a work not valid for nomenclature; accordingly *Pecten* Müller 1776 stands with *P. maximus* (L.) as type."

Von Teppner's *Philippia* is a junior homonym, but even if that were not so its status would be that of a synonym for *Pecten*, for it was actually intended to replace this genus. *Deperetia*, *Heritschia* and *Jaworskia*, proposed as subgenera of *Philippia*, must also be synonymized; furthermore, their types are clearly referable to *Pecten*.

In his paper, The Genus *Pecten* in the West Pacific (1950, p. 277), Fleming said: "The West Pacific species for which the name *Notovola* Finlay, 1927, was proposed, are too close to European species to warrant even subgeneric separation, . . ." In a subsequent paper (1951, p. 128), he said, ". . . *Notovola* Finlay, . . . has no phylogenetic unity . . . *P. novaezealandiae* has fossil relations (*tainui* Fin., *toi* Fleming) linking it with the Mediterranean *jacobaeus* L., which students of the Pectinidae agree to be closely akin to *maximus* L., . . ."

KEY TO THE EASTERN PACIFIC SPECIES OF *Pecten*

1. Shell nearly orbicular; ribs of right valve rounded and sloping; interspaces quite wide, particularly on left valve; concentric lamellae on each valve extremely fine
 *sericeus* Hinds
 (Galapagos Islands; Ecuador to northern Gulf of California)

1. Shell longer than high; ribs of right valve squarish and sharply angled; interspaces narrower than *sericeus*; concentric lamellae on each valve very fine, but only half as numerous as on *sericeus*.
diegensis Dall
 (Bodega Bay, California, to Cape San Lucas, Lower California, Mexico)

Pecten sericeus Hinds 1845

Plates 50-51

Pecten sericeus Hinds, 1845, p. 60, pl. 17, figs. 1, 1a. "Inhab. Bay of Panama. In fifty-three fathoms, on a muddy floor."

[non] *Pecten sericeus* Verneuil. Keyserling, 1846, p. 246, pl. 10, fig. 12. "Aus den Permischen Schichten im grauen Mergelkalke an der Uchta des Wymm, und im Kalksteine am Wel bei Dorfe Kischerma." [= *Avicula sericea* Verneuil in Murchison, Verneuil & Keyserling, 1845, p. 321, pl. 20, fig. 15.]

[non] *Pecten sericeus* Grönwall & Harder, 1907, p. 28. Denmark; Danian, upper Cretaceous.

Pecten sericeus Hinds. Dall, 1908, p. 400. "U.S.S. *Albatross*, station 3368, near Cocos Island, Gulf of Panama [*lapsus calami*; Cocos Island, Costa Rica], in 66 fathoms, rocky bottom, temperature 58° .4 F."

Pecten (Pecten) sericeus Hinds. Hertlein, 1935, p. 303, pl. 18, figs. 14, 15; pl. 19, figs. 3, 4. Panama to Mazatlan, Mexico.—Hertlein & Strong, 1946, p. 56. Santa Inez Bay, Gulf of California, to Panama. Also Maria Madre Island, Clarion Island and Cocos Island.

Pecten (Janira) sericeus Hinds. M. Smith, 1944, p. 52, fig. 692A.

Pecten sericeus Hinds. Keen, 1958, p. 69, fig. 125. "The southern part of the Gulf of California to Panama, . . ."

Holotype: Previously reported at British Museum, but not traceable there at present (1958).

Type locality: Panama Bay.

Original description: Testâ orbiculari, plano-subconvexâ, aequiauriculatâ, velutinâ, valvâ sinistrâ planulatâ, propè umbonem subconcavâ, fuscâ, costis viginti-quatuor, lateribus ad angulum planulatis, cum interstitiis velutinis; valva dextrâ subconvexâ, pallidâ, costis consimilibus, interdum subgeminis; auriculis aequalibus, rectis, velutinis, plicis duabus obsoletis; intùs albâ.

Additional description: Shell nearly orbicular and rather compressed. Average adult specimen 70 mm in height and 75 in length; hinge line

less than half length of disk. Right valve gently convex; 22 or 23 ribs, rounded in juvenile stage but usually sharply angled in adult; infrequently rather flat on top and with one or two grooves or a single ridge; interspaces somewhat wider than ribs; minute concentric lamellae covering disk, but often worn off tops of ribs; auricles equal, rather small for size of disk, gently convex, with oblique margins, and covered with minute concentric lamellae. Left valve nearly flat; central portion of disk usually shallowly concave, but occasionally slightly convex; ribs narrow and rounded in juvenile stage, usually becoming rather sharply angled later; interspaces wide, very infrequently with a low riblet near ventral margin; auricles gently concave and with two or three weak ridges; minute concentric lamellae covering disk and auricles. Right valve white, yellow-white or pale brown; left valve yellow-white, yellow, orange-yellow, brown or red-brown, with both lighter and darker blotches and streaks.

Additional descriptive notes: Several adolescent specimens from Cocos Island, Costa Rica, were examined and found to differ in being more compressed, slightly higher than long (rather than the reverse) and having a shorter hinge line. No doubt adult specimens are relatively the same, but the author feels that the distinctions are not sufficiently important to merit subspecific rank for this localized form.

Geographical Range: Angel de la Guarda Island, Gulf of California, to La Plata Island, Ecuador; Galapagos Islands. Previous records indicated Santa Inez Bay, Gulf of California, to be the northern limit, and Panama Bay the southern. Hancock expeditions collections increased the northern limit by about 480 miles, the southern by about 500, and established the first Galapagos Islands records.

Geochronological range: Known only from the Recent.

Bathymetric range: Recorded in 7 to 85 fathoms.

Ecological data: Usually found in mud or sand bottoms, occasionally rock; associated with nullipores, calcareous algae, coralline and coral.

Hancock Expeditions Collecting Stations:

GALAPAGOS ISLANDS: Albemarle Island, 30 fathoms, rock, coral, nullipores, sta. 147-34; 58-60 fathoms, sand, nullipores, sta. 190-34; between Albany and James Islands, 50-70 fathoms, rock, sta. 183-34.

ECUADOR: Off La Plata Island, 7-10 fathoms, rock, nullipores, sta. 213-34.

COCOS ISLAND, COSTA RICA: Chatham Bay, 47 fathoms, coarse white sand, sta. 780b-38.

CLARION ISLAND, REVILLA GIGEDO ISLANDS, MEXICO:

Sulphur Bay, 57 fathoms, nullipores, sta. 137-34.

ANGEL DE LA GUARDA ISLAND, GULF OF CALIFORNIA:

62-76 fathoms, sand, sta. 1080-40.

***Pecten diegensis* Dall 1898**

Plates 52-53

Pecten floridus Hinds, 1845, p. 60, pl. 17, figs. 6, 6a. "Inhab. San Diego, California. In five fathoms, among mud."

[*non*] *Ostrea florida* Gmelin, 1791, p. 3330. "Habitat . . ."

Pecten (Vola) floridus Hinds. Kobelt, 1887, p. 212, pl. 57, fig. 2. "bei San Diego, in Californien."

Janira florida Hinds. Cooper, 1888, p. 244.

Pecten (Janira) floridus Hds. Williamson, 1892, p. 193. San Pedro.

Pecten (Pecten) diegensis Dall, 1898, p. 710. "Pleistocene of San Diego; Hemphill. Living on the adjacent shores from Monterey, California, southward." New name for *P. floridus* Hinds, *non* *Ostrea florida* Gmelin.

Pecten diegoensis [*sic*] Dall. Keep, 1904, p. 39.

Pecten (Pecten) diegensis Dall. Arnold, 1906, p. 127, pl. 51, figs. 1, 1a, 1b. Previous records cited.

Pecten (Janira) stearnsii Dall variety *diegensis* Dall. Grant & Gale, p. 223, pl. 3, fig. 4. Pliocene of Ventura County, California. Also previous fossil records.

Pecten (Pecten) diegensis Dall. Hertlein, 1935, p. 302, pl. 19, figs. 5, 6. Monterey Bay, California to the San Benito Islands, Lower California.—Hertlein & Strong, 1946, p. 56. "Cordell Bank [off Bodega Bay], California, to Gorda Banks, off Cape San Lucas, Lower California."

Holotype: British Museum.

Type locality: San Diego, California.

Original description: Testâ orbiculari, plano-subconvexâ, aequiauriculatâ; valvâ sinistrâ planulatâ, propè medium subelevatâ, rufescente sparsim albo maculatâ, costis viginti-duo ad latera compressis, supernè rotundatis cum interstitiis laminis minimis epidermidis transversim striatis; valvâ dextrâ subconvexâ. pallescente, costis quadratis, mediò sulco impressis; auriculis aequalibus, rectis, laevibus, epidermide indutis; intùs albâ, versùs auriculas et margines saturatè fuscâ.

Additional description: Shell averaging about 60 millimeters in altitude, longer than high, inequivalve, plano-convex, or nearly so,

equilateral and with smooth margins; base evenly rounded; sides slightly concave above. Right valve somewhat convex (more pronounced near the umbo), and ornamented by about 22 or 23 prominent T-rail-shaped ribs, flattened, and generally longitudinally ridged or sulcated on top, which overhang deep, narrow, flat-bottomed interspaces; whole surface sculptured by numerous fine, sharp, incremental lines; hinge line slightly less than one-half length of disk; ears equal, slightly convex, rectangularly truncated, sculptured by fine, sharp, incremental lines; anterior ear with small byssal notch. Left valve flat or nearly so, generally concave near apex, ornamented by 21 or 22 prominent, narrow, convex-topped ribs, which are separated by concave-bottomed interspaces about equal in width to the ribs; whole surface prominently sculptured by numerous regular, fine, sharp, concentric, raised lines; ears concave, convexly truncated, and ornamented by the same concentric sculpture as the disk. Color, red and reddish brown, the left valve always being much darker than the right. (Arnold, 1906, p. 128)

Additional descriptive notes: The average adult specimen is 90 mm in height, 110 in length and 20 in diameter. After his own description of this species Arnold commented, "Mrs. Oldroyd has two specimens taken from fishermen's nets at San Pedro, which measure over 150 millimeters (6 inches) in length, and are exceptionally high colored for this species."

Although Arnold said the right valve has 22 or 23 ribs and the left 21 or 22, such specimens must be quite uncommon; all that the author has ever seen had 18 to 21 on the right valve and 17 to 20 on the left.

The commensal gastropod *Capulus californicus* Dall is often attached to the anterior side of the umbo of the right valve, as in *Chlamys hastata* (Sowerby), and lives only on these two species, never alone or on any other mollusca.

Remarks: Although closely related to *Pecten sericeus* Hinds, this species is quite distinct and differs in the following respects: less orbicular (length considerably greater than height); ribs of right valve always squarish, flat-topped, and often longitudinally ridged; ribs of left valve wider and rounded; interspaces of both valves narrower (especially left); auricular margins perpendicular (or nearly so) rather than oblique; hinge line relatively longer; concentric lamellae on disks and auricles only half as numerous.

Geographical range: Cordell Bank, off Bodega Bay, northern California, to Gorda Banks, off Cape San Lucas, Lower California. Also recorded from Guadalupe Island, Mexico, 180 miles west of central Lower California.

Geochronological range: ?Pliocene, Pleistocene, Recent.

Bathymetric range: 5 to 200 fathoms.

Ecological data: Usually found on or swimming above the following varieties of bottom: shale, rock, gravel, gray sand, green sand, mud; associated with coralline, nullipores, kelp, sponge.

Hancock Expeditions Collecting Stations:

WESTERN LOWER CALIFORNIA: 7 stations, all in vicinity of Cedros Island; 16-49 fathoms, rock, sand.

SOUTHERN CALIFORNIA AND SANTA BARBARA ISLANDS: 27 stations; 15-150 fathoms, gravel, sand, mud.

Subgenus **PATINOPECTEN** Dall 1898

Patinopecten Dall, 1898, p. 695. [Proposed as a section of *Chlamys*.]

Type species: *Pecten caurinus* Gould, 1850, p. 345; type locality: Port Townsend, Washington [then Oregon Territory].

Blanckenhornia von Teppner, 1922, p. 260. [Proposed as a subgenus of *Philippia* von Teppner, 1922, p. 221; see synonymy of *Pecten*, this paper.] Type species: *Pecten (Patinopecten) lohri* Hertlein, 1928, p. 93; type locality: Pliocene of California. [New name for *Pecten (Patinopecten) oweni* Arnold, 1906, p. 63, pl. 8, figs. 1, 1a, 1b; non *Pecten oweni* de Gregorio, 1884b, p. 133.]

Original diagnosis: Valves with small ribs, flat on the right valve and sometimes dichotomous; smaller and more rounded on the left valve; concentric sculpture inconspicuous; radial striae absent or obsolete; ears subequal; valves nearly equilateral.

Additional diagnostic notes: Adult shells are very large. Both valves are quite compressed, the right being slightly deeper.

Remarks: *Blanckenhornia* was based on medial sulcations of the ribs, a feature not of supraspecific significance.

This subgenus contains only two living species: *P. caurinus* Gould and *P. caurinus yessoensis* (Jay). Both attain the largest size of any living *Pectinidae*, the maximum reported for the typical being a length of 288 mm and height of 198 mm, that for the subspecies being a length of 214 mm and height of 180 mm.

Pecten (Patinopecten) caurinus Gould 1850

Plate 54

Pecten caurinus Gould, 1850, p. 345. "Hab. Port Townsend, Admiralty Inlet, Oregon" [Washington].—Gould, 1852, p. 458; 1856, pl. 42, figs. 569, 569a, 569b.

- Pecten Heermanni* Conrad, 1856, p. 267. California. [Upper Pliocene near Santa Barbara, *vide* Arnold, 1906, p. 102.]
- [*non*] *Pecten (Lyropecten) Heermanni* Conrad. Dall, 1898, p. 701. [= *Pallium estrellanum* Conrad, 1857b, p. 313. Estrella Valley, Cal. Miocene and Pliocene of California.]
- Pecten Meekii* Conrad, 1857b, p. 313. "San Raphael Hills." [Upper Pliocene near Santa Barbara, *vide* Arnold, 1906, p. 102.]
- Pecten meekii* Merriam, 1900, p. 222. Lower Pliocene; San Felician Creek, Ventura County, California.
- Amusium caurinum* Gould. Carpenter, 1864, p. 645. Records (Recent) from Vancouver to California.
- [*non*] *Pecten caurinus* Gould. Dall, 1886, Bull. Mus. Comp. Zool., vol. 12, p. 216, pl. 5, fig. 4. "... young specimen . . . Sitka, Alaska." [= *Cyclopecten (Delectopecten) vancouverensis* (Whiteaves).]
- Pecten caurinus* Gould. Kobelt, 1887, p. 152, pl. 43, fig. 1. "am nordöstlichen Amerika [*lapsus calami*; "nordwestlichen" Amerika], von Alaska bis nach Californien herunter."
- Pecten (Patiniopecten) caurinus* Gould. Dall, 1898, p. 710. Miocene of California Blake. Living about Puget Sound.—Arnold, 1906, p. 101, pl. 38, figs. 1, 1a, 1b; pl. 39, figs. 1, 2. Pliocene records from Washington to Southern California; Pleistocene from Santa Barbara to San Pedro, California. "Living: Puget Sound (Carpenter)."
- Pecten (Pecten) merriami* Arnold, 1906, p. 99, pl. 30, figs. 1, 1a, 2. New name for *P. meekii* Merriam, 1900, "not of Conrad, 1857."
- Pecten (Chlamys) caurinus* Gould. Dall, 1921, p. 19. Wrangell, Alaska, to Siletz Bay, Oregon.—Oldroyd, 1924a, p. 57, pl. 4, fig. 1; pl. 6, fig. 1. [Both under "Section" *Patiniopecten*.]
- Pecten oregonensis* Howe, 1922, p. 98, pl. 11, figs. 1, 2; pl. 12, figs. 1, 2. Pliocene of Coos Bay, Oregon.
- Chlamys (Patiniopecten) caurinus* (Gould). Bavay, 1936 [*ex parte*], p. 312. [In synonymy: *Pecten yessoensis* Jay; "*poecilus* A. Adams (juv.)." *P. yessoensis* Jay (1857, p. 293, pl. 3, figs. 3, 4; pl. 4, figs. 1, 2; "Habitat, Hakodadi.") now *P. caurinus yessoensis* (Jay), the Japanese subspecies of *caurinus*. Only previous or subsequent reference (or usage of name) for *poecilus* A. Adams located: listed by Paetel, 1890, p. 232.]
- Pecten caurinus* Gould. Hertlein, 1940, p. 68. "Channel Island, Orca Inlet, Cordova, Alaska, to off Point Reyes, California [38° N]."
- Patiniopecten caurinus* Gould. Morris, 1952, p. 15, pl. 3. Alaska to Humboldt Bay, California.

Patinopecten caurinus (Gould 1850). Fitch, 1953, p. 44, fig. 10.

Wrangell, Alaska, to Eureka, California.

Holotype: Museum of Comparative Zoology, Harvard College.

Type locality: Port Townsend, Admiralty Inlet, Puget Sound, Washington. For explanation of Gould's designation "Oregon" see *Type locality* for *Chlamys hastata hericea* (Gould), this paper.

Original description: T. trigono-orbicularis, haud crassa, inequivalvis, sub-equilateralis; valva superior convexiuscula, rubra, striis concentricis tenuibus insculpta, costis humilibus rotundatis vel interdum sub-duplicatis ad 20 ornatis; valva inferior convexa, alba, versus marginem rubricans, radiis ad 22 elevatis, quadratis, longitrorsum striatis; natibus rosaceis compressis; auribus transversis, sub-equalibus, radiatim striatis; intus lactea, rosaceo fimbriata. Long. $2\frac{3}{4}$; lat. $2\frac{1}{4}$; alt. 1 poll.

Additional description: Shell large, average adult specimens measuring 150 mm in altitude, slightly oblique, inequivalve and compressed; auricles nearly equal. Right valve larger than left and having 18 to 22 squarish flat-topped ribs which occasionally show faint radial striae and/or longitudinal ridges; interspaces flattish and becoming wider toward ventral margin; fine concentric growth lines covering disk. Posterior auricle flat, with perpendicular margin and strong incremental lines; anterior auricle rather narrow, with faint (often obsolescent) radial ridges, sharp incremental lines and a prominent convex fold next to the disk; byssal notch moderately deep and no ctenolium. Left valve smaller than right and slightly less convex; 18 to 22 low and gently-rounded ribs; fine concentric lamellae covering disk. Posterior auricle having strong incremental lines and sometimes faintly ridged; anterior auricle having an oblique margin, a prominent concave fold and strong incremental lines. Right valve yellowish-white to golden-brown; left valve usually pale to deep brown, rare specimens being red-brown or purple.

Remarks: The holotype was a young shell. In 1918 W. J. Eyerdam dredged a specimen outside of Wrangell Narrows, Alaska, having some of the ventral margin broken off but still measuring 288 mm in length and 198 mm in height, the largest so far recorded.

The Japanese subspecies *Pecten caurinus yessoensis* (Jay) differs from *P. caurinus* in the following respects: right valve considerably more convex, auricles higher and longer, byssal notch much less pronounced and fine tessellate sculpture on left valve.

Geographical range: Channel Inlet, Orca Inlet, Cordova, Alaska, to Point Reyes, California.

Geochronological range: Miocene (?), Pliocene, Pleistocene, Recent.

Bathymetric range: 20 to 100 fathoms (possibly deeper).

Ecological data: Found in sand or mud bottoms.

Hancock Expeditions Collecting Stations:

OREGON: 20 to 76 fathoms, sand or mud; sta. 1471-42, 1481-42, 1497-42 (43° 37' 40" N to 44° 50' 45" N; 124° 15' 53" W to 124° 22' 22" W).

Subgenus **OPPENHEIMOPECTEN** von Teppner 1922

Oppenheimopecten von Teppner, 1922, p. 254. [Proposed as a subgenus of *Philippia* von Teppner, 1922, p. 221.] Type species: *Pecten subbenedictus* Fontannes, 1878, p. 99, pl. ii, fig. 1; type locality: Miocene of the Visan Basin, Vaucluse, France.

Convexopecten Tucker-Rowland, 1938c, p. 82. [Proposed as a subgenus of *Pecten*.] Type species: *Pecten Josslingii* Sowerby in J. Smith, 1847, pp. 413, 419, pl. 16, figs. 10-12; type locality: Upper Tertiary of River Tagus, Portugal.

Original diagnosis: Ungleichklappig, rechte Schale stark convex (Wirbel stark eingekrümmt) mit gerundeten Rippen, breiter als die Zwischenräume. Ohren gross, ungleich. Rippen der linken Schale flach und breit, schmaler als die Zwischenräume. Konzentrische Verzierung der rechten Schale sehr schwach, der linken deutlich. (von Teppner in Roger, 1939.)

Translation: Inequivalve, right valve strongly convex (umbo strongly incurved) with rounded ribs, broader than the interspaces. Ears large, unequal. Ribs of left valve flat and broad, narrower than the interspaces. Concentric sculpture of right valve very weak, the left distinct.

Additional diagnosis: Of the above criteria, the most important are the strongly convex right valve and strongly "incurved" umbo, the latter being also strongly inflated. The left valve is shallowly to moderately concave, the size of the auricles of the right valve in relation to that of the disk is variable and the ribs of the left valve may be rather round.

Remarks: This subgenus effectively separates the forms having deeply convex right valves with inflated umbos and varyingly concave left valves from such groups as those of *Pecten maximus* (Linné) and *P. jacobaeus* (Linné).

Among Recent species referable to *Oppenheimopecten* are the eastern Pacific *vogdesi* Arnold, *galapagensis* sp. nov. and *hancocki* sp. nov., the western Pacific *puncticulatus* Dunker, *excavatus* Anton (= *Pecten sinensis* Sowerby) and *fumatus* Reeve, the Indian Ocean *dorothyae* Melvill, and the Red Sea *erythraeensis* Sowerby.

KEY TO THE EASTERN PACIFIC SPECIES OF *Oppenheimopecten*

1. Right valve red-brown to pale brown; left valve with intercalary riblets; right valve with 19-21 ribs, left with 18-20; umbo of right valve strongly inflated
 *vogdesi* Arnold
 (Punta Eugenia, western Lower California, Mexico; Gulf of California to Paita, Peru)
1. Right valve white; left valve without intercalary riblets; umbo of right valve weakly inflated
 2. Right valve with 16-17 ribs, left with 15-16; hinge line longer than *vogdesi*; interior white
 *hancocki* sp. nova
 (Cocos Island, Costa Rica)
 2. Right valve with 15 ribs, left with 14; hinge line shorter than *vogdesi*; interior pink or rose on auricles and along sub-margins *galapagensis* sp. nova
 (Galapagos Islands)

***Pecten* (*Oppenheimopecten*) *vogdesi* Arnold 1906**

Plate 55

Pecten dentatus G. B. Sowerby, 1835, p. 109. "Hab. ad Sanctam Elenam [Santa Elena, Ecuador] . . . among sand and stones in twelve fathoms."

[non] *Pecten dentatus* J. de C. Sowerby, 1827, p. 143, pl. 574, fig. 1. "Bugbrook and Staverton, in Northamptonshire." [Fossil.]

[non] *Pecten excavatus* Anton. Valenciennes, 1846, pl. 19, fig. 1. [= *P. vogdesi* Arnold; non *Pecten excavatus* Anton, 1839, p. 19, no. 710. "China."]

Vola dentata Sow. H. & A. Adams, 1858, p. 554. [non *P. dentatus* J. de C. Sowerby, 1827.]

Janira dentata Sby. Carpenter, 1864, p. 645. " = *excavata*, Val. Ven. Like *media*. From the Gulf fauna. Beach-20 fm. Cp." [non *P. dentatus* J. de C. Sowerby.]

- Pecten (Vola) dentatus* Sowerby. Kobelt, 1888, p. 155, pl. 44, figs. 1, 2. "an Westcolumbien, bei Santa Elena von Cuming . . ." [*non P. dentatus* J. de C. Sowerby.]
- Pecten dentatus* Sowerby. Verrill, 1897, p. 57. "Pacific coast of America, from the Gulf of California to South America. [*non P. dentatus* J. de C. Sowerby.]
- Pecten (Pecten) dentatus* Sowerby. Arnold, 1903, p. 104, pl. 12, figs. 1, 1a. Pliocene: San Diego. Pleistocene: Santa Barbara to San Diego. Living: Gulf of California. [*non P. dentatus* J. de C. Sowerby.]
- Pecten (Pecten) vogdesi* Arnold, 1906, p. 100, pl. 33, figs. 1, 1a; pl. 34, fig. 1. San Pedro formation (Pleistocene), San Pedro, California.
- [*non*] *Pecten (Pecten) excavatus* Anton. Arnold, 1906, p. 134, pl. 46, figs. 1, 1a, 1b. Gulf of California. ". . . erroneously reported from China." [Arnold mistaken; = *P. vogdesi* Arnold. *P. excavatus* Anton restricted to south and central China, Formosa, Ryukyu Islands and southern Japan; *P. sinensis* Sowerby, 1842 (p. 48, pl. 16, figs. 120, 121, 134) is a synonym.]
- Pecten dentatus* Sowerby. Dall, 1909, p. 255. Santa Elena, Ecuador, to Paíta, Peru. [*non P. dentatus* J. de C. Sowerby.]
- Pecten (Janira) dentatus* Sowerby. Lamy, 1909, p. 213. "Basse Californie." [*non P. dentatus* J. de C. Sowerby.]
- Pecten dentatus* Sowerby. Dall, 1909, p. 255. Santa Elena, Ecuador, to Paíta, Peru. [*non P. dentatus* J. Sowerby.]
- Pecten (Euvola) cataractes* Dall, 1914, p. 121. New name for *P. dentatus* G. B. Sowerby, *non P. dentatus* J. Sowerby. Gulf of California.
- Pecten (Pecten) heimi* Hertlein, 1925, p. 9, pl. 1, fig. 3; pl. 3, fig. 3. "southern part of Arroyo San Gregorio, Lower California; . . . Lower Pliocene?"
- Pecten (Janira) vogdesi* Arnold. Grant & Gale, 1931, p. 228, pl. 3, figs. 3a, 3b. Pliocene of California. Pleistocene of California and Lower California. Living: Gulf of California.
- Pecten excavatus* Turton [*lapsus calami*; Anton] (*P. dentatus* Sby.). Pilsbry & Lowe, 1933, p. 139.
- Pecten (Pecten) vogdesi* Arnold. Hertlein, 1935, p. 304, pl. 19, figs. 16, 17. "Magdalena Bay, Lower California; Gulf of California and south to Paíta, Peru. Pliocene and Pleistocene of California and Lower California."
- Holotype*: British Museum.
- Type locality*: Santa Elena, Ecuador.

Original description: Pect. testâ valdè inaequalvi, aequilaterali; auriculis aequalibus; valvâ [sinistra] planulatâ sulcato-radiatâ et striatâ, alterâ valdè convexâ, laevigatâ, radiatim sulcatâ, margine ventrali profundè dentato: long. 3.75, lat. 1.5, alt. 3.5 poll.

Additional description: Shell inequivalve and longer than high; average fully adult specimen about 110 mm high and 100 mm long; left valve smaller than right and recessed into latter at ventral margin to depth of 6 to 8 mm, hinge line slightly more than half length of disk. Right valve deeply convex; umbo strongly inflated and projecting above hinge margin (starting to do so when shell reaches height of from 35 to 40 mm); hinge recurved at maturity, with contact surfaces of cardinal crura at right angle to left valve; 19 to 21 rounded ribs, strongly produced ventrally and resulting in prominently dentate margin; interspaces about half as wide as ribs; surface of disk covered by very minute growth striae which become stronger near ventral margin. Interior of disk with deep grooves near ventral margin, resulting from external ribs; reverse surfaces of interspaces flat and ridged. Anterior auricle very slightly longer than posterior; strong convex fold 2 or 3 mm above disk; upper portion of auricle flat, angled at about 45° from perpendicular, finely concentrically lamellose and with 4 or 5 riblets; byssal notch shallow and ctenolium absent after shell reaches height of 40 to 45 mm. Posterior auricle convex and with 6 to 11 faint riblets covered by fine concentric lamellae. Left valve shallowly concave; 18 to 20 rather flat ribs, with 4 or 5 small riblets next to submargins; ribs having one to three grooves near ventral margin; interspaces slightly wider than ribs, having a low central riblet and being finely concentrically lamellose. Interior of disk grooved near ventral margin as result of external ribs, grooves becoming shallower toward umbonal area; reverse surfaces of interspaces flattened and ridged; low rounded ridge parallel to submargin at base of each auricle and terminating in small white knob at lower end; cardinal crura prominent and with contact surfaces at right angle to disk. Both auricles concave, concentrically lamellose, and often slightly longer than those of right valve; 2 or 3 prominent riblets adjoining hinge margin, with occasionally 2 or 3 indistinct riblets below them. Exterior of right valve pale yellow-brown to deep red-brown; juveniles often purple or lavender, with brown and white blotches and streaks. Left valve medium to deep brown in adult stage, occasionally with purple, lavender, yellow or white maculations on the umbo; juveniles often very brightly colored. Interior of right valve mostly white, with auricles brown and disk usually having concentric band of brown or

purple just inside juncture with left valve; left valve various shades of brown, purple-brown or rose-brown, with large white central area.

Geographical range: Punta Eugenia, western Lower California, Mexico, and entire Gulf of California, to Paita, Peru. Previous records indicated Magdalena Bay, Lower California, as the northern limit in the Pacific Ocean, but the Hancock expeditions extended it by about 300 miles.

Geochronological range: Pliocene, Pleistocene, Recent.

Bathymetric range: Recorded in 2 to 120 fathoms.

Ecological data: Usually found in sand, sandy mud, or mud bottoms, associated with coral, coralline or sponge.

Hancock Expeditions Collecting Stations:

ECUADOR: La Plata Island; 10 fathoms, bottom sample 500.

COSTA RICA: Cocos Bay, 2 fathoms, sand, sta. 116-33; Port Parker, 5-10 fms., sandy mud, sta. 936-39.

GULF OF CALIFORNIA: 27 stations; 8-100 fathoms, sand, mud.

WESTERN LOWER CALIFORNIA: Punta Eugenia (farthest north), 26 fathoms, rock, coralline, sta. 1260-41; 4 stations, 14-26 fathoms, rock, sand.

***Pecten* (*Oppenheimopecten*) *galapagensis* sp. nov.**

Plate 56

Shell inequivalve, thin and of moderate size, largest known specimen (the holotype) 44 mm in height and 49 in length; left valve smaller than right and recessed into that valve at ventral margin to depth of 4 mm; hinge line well over half as long as disk. Right valve quite convex, but less so than *Pecten vogdesi* Arnold; umbo not produced above hinge margin; 15 smooth and gently rounded ribs, with a very shallow riblet adjoining each submargin; interspaces narrower; fine concentric lamellae covering upper half of disk, with very fine growth striae below. Interior of disk with grooves corresponding to external ribs, becoming shallower toward umbo; reverse surfaces of interspaces flattened and (near ventral margin) angulately ridged; auricular crura next to submargins small and elongate; cardinal crura low and flat. Anterior auricle rather large, flat, and with margin slanting inward from hinge line to byssal notch; weak convex fold just above disk; 3 or 4 small radial ridges above fold; byssal notch shallow and ctenolium of 3 to 5 teeth; auricle covered with fine wavy concentric lamellae projecting above hinge line; posterior auricle rather large and high, with margin slanting inward from hinge

margin to disk; gently convex, with shallow concave area halfway between hinge margin and base of auricle; several faint radial ridges in juvenile stage, obsolete at maturity; surface covered with fine concentric lamellae projecting above hinge line. Left valve with pronounced depression of central area; 14 shallow ribs, rounded but somewhat flattened on top; juvenile specimens with two narrow ridges adjoining each submargin, ridges becoming almost completely obsolete at maturity; interspaces wider than ribs. Both auricles rather large, concave, and with margins slanting inward from hinge margin to disk; several indistinct radial ridges present. Surface of disk and auricles covered with fine concentric lamellae, continuous and unbroken from hinge margin of anterior auricle to that of posterior auricle; lamellae always inclined in direction of margins. Color of right valve: disk mostly white, with pale brown mottling on umbo; auricles pale brown; interior white, except for few streaks or blotches of pink or rose along submargins and on auricles. Left valve light brown, dark brown or rose, mottled with lighter and darker colors; auricles white, yellow-brown or rose-pink; interior mostly white, with dark brown or rose at ventral margin and blotches of brown and purple along submargins and in umbonal area.

Holotype: 44 mm in height and 49 in length; diameter 15 mm; hinge margin 29 mm; Allan Hancock Foundation.

Type locality: Tagus Cove, Albemarle Island, Galapagos Islands, in 10-18 fathoms, sand and shell; Hancock station 157-34; 0° 16' 08" S, 91° 22' 38" W; January 15, 1934.

This species also occurred at the following Galapagos stations: 143-34, off Wenman Island, 100-150 fathoms, coral and nullipores; 147-34, Tagus Cove, Albemarle Island, 30 fathoms, rock, coral, nullipores; 149-34, same place, 20 fathoms, rock and nullipores; 172-34, Stephens Bay, Chatham Island, 12 fathoms, rock, boulders, gorgonids; 182-34, off James Bay, James Island, 30 fathoms, coarse sand; 201-34, off Gardner Bay, Hood Island, 25-35 fathoms, rock.

Remarks: This species is quite distinct from *Pecten vogdesi* Arnold, although obviously related. The most apparent differences are the white right valve, sharply angled auricles and number of ribs. Other distinctions are the longer hinge line, less convex right valve, uninflated umbo of that valve, absence of intercalary riblets on the left valve, profuse lamellae on that valve and coloring of both valves. From *P. hancocki* it can be distinguished by the length of the hinge line, larger and sharply angled auricles, lower and flatter ribs of the left valve, number of ribs

(*P. hancocki* having 1 or 2 more on each valve), less complex surface sculpture of the left valve, nearly smooth right valve and different coloring.

The holotype is the largest specimen found, but it does not seem to be mature; the average size of other species in the subgenus would indicate that its maximum height may be from 70 to 80 mm.

This species is apparently restricted to the Galapagos Islands. Neither *Pecten vogdesi* nor *P. hancocki* have been recorded from the area.

Pecten (Oppenheimopecten) *hancocki* sp. nov.

Plate 57

Shell inequivalve and of moderate size, known specimens averaging 43 mm in height and 45 in length; obliquity rather pronounced, with disk produced posteriorly and posterior submargins longer and more steeply angled than anterior ones; left valve smaller and recessed into right valve at ventral margin to depth of 3 or 4 mm; hinge line less than half as long as disk. Right valve quite convex, but less so than *Pecten vogdesi* Arnold; umbo seldom produced above hinge margin; 16 or 17 strong rounded ribs, with a small riblet adjoining each submargin; interspaces narrower; disk covered by very thin and concentrically striate layer of shell, with fine concentric lamellae beneath; lamellae visible where outer layer worn off: on portions of submargins and in interspaces of top one-third to two-thirds of disk. Interior of disk with moderately deep grooves resulting from external ribs; reverse surfaces of interspaces with edges angulated and occasionally thickened, but usually not; small elongate nodule at base of anterior auricle and larger one at base of posterior; cardinal crura rather large in area but not strongly produced. Anterior auricle rather small and shallowly convex; fasciole narrow, with concentric fold above it; 2 or 3 stronger radial riblets above fold and one or two very weak ones above them; byssal notch very shallow; ctenolium of 3 to 5 teeth present until shell reaches height of about 25 mm, absent in adult specimens; surface of auricle with same outer layer as disk and very fine (but seldom visible) concentric lamellae beneath. Posterior auricle with varying number of very faint radiating ridges; about 1 mm shorter than anterior auricle and with same surface sculpture. Left valve almost flat, central portion being only slightly depressed; 15 or 16 strong rounded ribs, with a low riblet adjoining each submargin; interspaces a little wider; surface originally covered by same thin striate layer as right valve, but outer layer worn off of upper one-half to two-thirds of tops of ribs and almost completely

off of interspaces, thus exposing a larger number of lamellae than are visible on right valve. Interior of disk grooved as result of external ribs, grooves becoming shallower toward umbo; reverse surfaces of interspaces flat and angulately ridged near ventral margin; two small nodules at base of anterior auricle and one rounded one with depressed center at base of posterior; cardinal crura as on right valve. Both auricles same length as corresponding auricles of right valve and having varying number of low riblets, most prominent near hinge line; sculpture as on disk, but with major portion of outer layer usually worn off. Color of right valve: mostly white, with umbonal area (and occasionally auricles) pale orange to pink-orange; interior grooves white, reverse surfaces of interspaces ecru, auricles and submargins pink or rose-pink. Color of left valve: orange or red-orange (sometimes mottled with white) in umbonal region, shading to pale brown or red-brown near ventral margin; tops of ribs (on lower one-third to one-half of disk) pale ecru or gray-white.

Holotype: 47 mm in height and 49 in length; diameter 17 mm; hinge line 22 mm; Allan Hancock Foundation.

Type locality: Chatham Bay, Cocos Island, Costa Rica, in 47 fathoms, coarse white sand; Hancock station 780b-38; 5° 33' 50" N, 86° 58' 45" W; January 14, 1938.

The species also occurred off Nuez Island, Cocos Island, in 31-50 fathoms, coralline; Hancock station 773-38.

Remarks: This species is quite distinct from its nearest relative, *Pecten vogdesi* Arnold. The most apparent differences are the white right valve with pale orange or pink-orange umbo and the smaller number of ribs, *P. vogdesi* having from 3 to 5 more. Other distinguishing features are the oblique disk, shorter hinge line, less convex right valve, less inflated umbo of that valve, rounded ribs and absence of intercalary riblets on the left valve, complex surface sculpture and the exterior and interior coloring.

Although the holotype is the largest specimen found, it is not fully adult; judging by the other species in its subgenus it probably attains a maximum height of from 70 to 80 mm.

Apparently this species is restricted to the Cocos Island area. *Pecten vogdesi* did not occur at any of the 7 Cocos Island Hancock stations in 1933 nor the 11 in 1938, and almost certainly does not live in the area. However, it is plentiful off Costa Rica, a little over 300 miles eastward.

In appreciation of the extensive support he has given marine research, this species is dedicated to Captain Allan Hancock.

Pecten (?var.) squarrosus Carpenter 1865
(**nomen dubium**; extra-limital)

Plate 10, fig. 1.

Pecten squarrosus Carpenter, 1864, p. 536. [*Nomen nudum*.] Footnote: "Of these forms, . . . the diagnoses are written, and will probably be found in one of the scientific periodicals for 1864." [Additional footnote saying species presumed to be from neighborhood of Santa Barbara, California; ". . . first found by Col. J." (Jewett)]

Pecten (?var.) *squarrosus* Carpenter, 1865, p. 179. [With description.]

Pecten squarrosus Carpenter, Kobelt, 1888, p. 281. "Hab. Sta. Barbara Californiae?—Valvae dextrae tantum repertae."

Pecten squarrosus [sic] Crprtr. Paetel, 1890, p. 234. "Californ."

Pecten squarrosus Cpr. Palmer, 1945, p. 99.

"*Pecten* (?var.) *squarrosus*" Carpenter. Palmer, 1958, p. 72, pl. 2, figs. 1-3.

Syntypes: Redpath Museum, McGill University, Montreal, Quebec, Canada.

Type locality: ? Syntypes (2) represent two species; locality of neither specimen verifiable.

Original description: P. testa orbiculari, aequilaterali, rubida, albido maculata; valva dextra convexa; costis xviii., aequalibus, testa jun. approximatis, testa adulta interstitiis aequalibus; costis et interstitiis regulariter undatis, striis crebris squamosis radiantibus ubique ornata; auriculis magnis, latissimis, subaequalibus; antica anguste fissata, serrata, postica sinuata; auriculis ambabus et regione contigua scabrose striatis; intus alba, linea cardinali alte sulcata. Long. 1.82, lat. 1.79, alt. .9.

Hab. 'Sta. Barbara,' teste Jewett.

Resembles a shell in Mus. Cuming, marked "*exasperatus*, var.", but does not agree with the diagnosis of that species. All Col. Jewett's valves were dextral. The locality needs confirmation.

Remarks: This is a perplexing species. Up to 1958 it had appeared in the literature only three times after Carpenter described it, Kobelt merely reprinting the original description, Paetel including the name in his catalogue (citing Kobelt), and Palmer referring to the types as being among those of Carpenter's in the Redpath Museum.

In 1956 the author wrote to Dr. Vicente Conde, of the Redpath Museum, requesting a photograph of the syntypes. He kindly furnished it, along with the measurements of the valves and the information that

Carpenter had written on the original label "*Pecten squarrosus* Cpr. Type. 'Sta. Barbara.' Also and really Florida. Jewett."

In her 1958 paper Palmer discussed *Pecten squarrosus* and gave her ideas as to the possible identities of the two specimens she designated syntypes, the two right valves Carpenter labelled "*Type*." As Palmer remarked, the left valve he also labelled "*Type*" must be disregarded, because of his statement that Jewett's valves were dextral.

Figure 1 on plate 10 of this paper is a photograph of the syntypes. Of the specimen on the left, Palmer said that it "... bears a resemblance ... to the holotype of *P. acanthodes* Dall (in Smith, 1937, pl. 9, fig. 3." Dall (1925b, p. 120) described *P. acanthodes* and gave the range as "... from Southern Florida to the Antilles.", but he did not figure the species; Maxwell Smith figured the holotype, but unfortunately his photograph shows only the interior of the right valve. Judging from a long series of *P. acanthodes* in the author's collection, this valve of Carpenter's cannot be referred to that species; it is a specimen of *Pecten muscosus* Wood (1828, pl. 2, fig. 2; = *Pecten exasperatus* Sowerby, 1842, p. 54, pl. 18, figs. 183-186). *P. acanthodes* differs from *P. muscosus* in being less convex, at least as long as it is high (often longer), in having posterior auricles of only moderate length, and in having shorter, finer, and more profuse scales, those of the central riblet on each major rib being very little stronger, if at all, than those of the adjoining riblets; its proper status is that of a subspecies of *muscosus*.

Of the specimen shown on the right in figure 1, plate 10, Palmer said it "... bears a resemblance to the holotype of *P. heliacus* Dall (1925b, p. 119-120) as figured in Maxwell Smith (1937, pl. 9, figs. 5a, 5b)" *Pecten heliacus* Dall is known only by the holotype, which was not figured until Smith reproduced photographs of it; his figure 5a shows the exterior of the left valve and 5b the interior of the right. Those figures, along with Dall's description, show that this valve of Carpenter's differs considerably from *P. heliacus* in being more convex, having a larger anterior auricle and a strongly produced anterior auricle (resulting in a much longer hinge margin), and in having wider ribs and different sculpture. Except for the longer posterior auricle and the less orbicular disk, this valve resembles *P. acanthodes*; it may be a geographical form of *P. muscosus*, being similar to some specimens of that species in the author's collection. Incidentally, *P. heliacus* must also be regarded a *nomen dubium*. It was described from a single specimen sent to Dall by the late shell dealer, Walter F. Webb; the locality

Webb gave was "Bahamas," but he was quite unreliable in regard to data; furthermore, no specimen resembling the holotype has ever been reported from the western Atlantic.

In summation, it is the author's contention that *Pecten squarrosus* Carpenter is a *nomen dubium*; of the two syntypes, for neither of which a locality can be verified, one is definitely referable to the western Atlantic *P. muscosus* Wood and the other is a puzzle.

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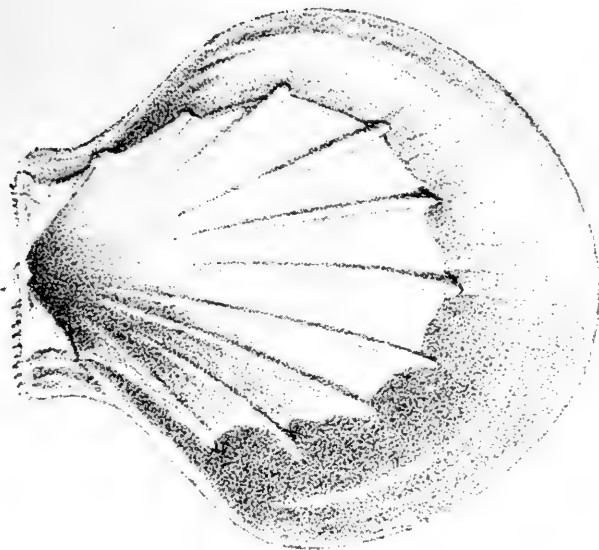
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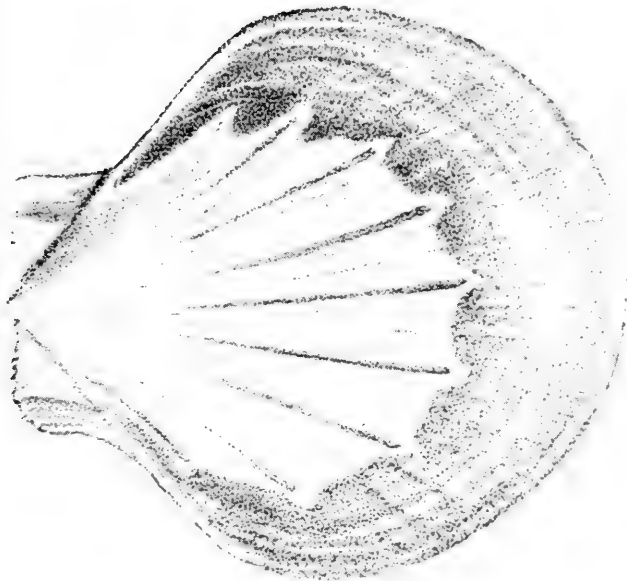
PLATES

PLATE 1

Propeamussium meridionale (E. A. Smith), 1885. Reproduction of original figures. *Challenger* station 158, about 1600 miles south of Western Australia, in 1800 fathoms. Height and length: 14 mm. P.



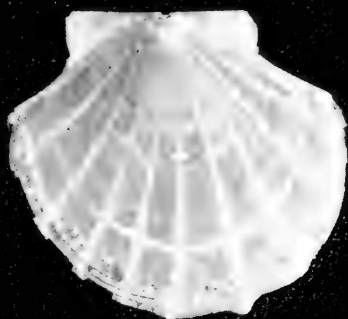
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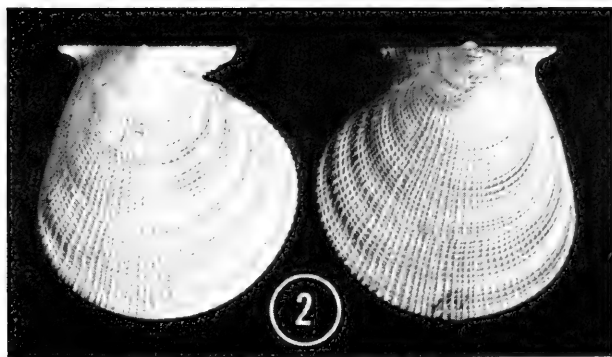
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PLATE 2

- Fig. 1. *Propeamussium malpelsonium* (Dall), 1908. Paratype. *Albatross* station 3374, off Malpelo Island, west Colombia, in 1823 fathoms. Height: 19.5 mm; length: 20 mm. (Grau collection. Photograph by R. V. George.) P.
- Fig. 2. *Cyclopecten* (*Hyalopecten*) *neoeceanicus* (Dall), 1908. Holotype. *Albatross* station 4721, SW of Galapagos Islands, in 2084 fathoms. Height and length: 12 mm. (U.S. National Museum collection, no. 110579. Photograph by F. B. Kestner, U.S.N.M.) P.



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PLATE 3

Procamusium (*Parcamusium*) *alaskense* (Dali), 1872. U.S. Fish Comm. station 3602, SW of Pribilof Islands, Bering Sea, in 80 fathoms. Height and length: 22 mm. (Grau collection.) P.



PLATE 4

Propeamussium (*Parvamussium*) *davidsoni* (Dall), 1897. Paratype.
U.S. Fish Comm. station 4470, Bowers Bank, Bering Sea, in 247
fathoms. Height and length: 9.5 mm. (Grau collection.) P.

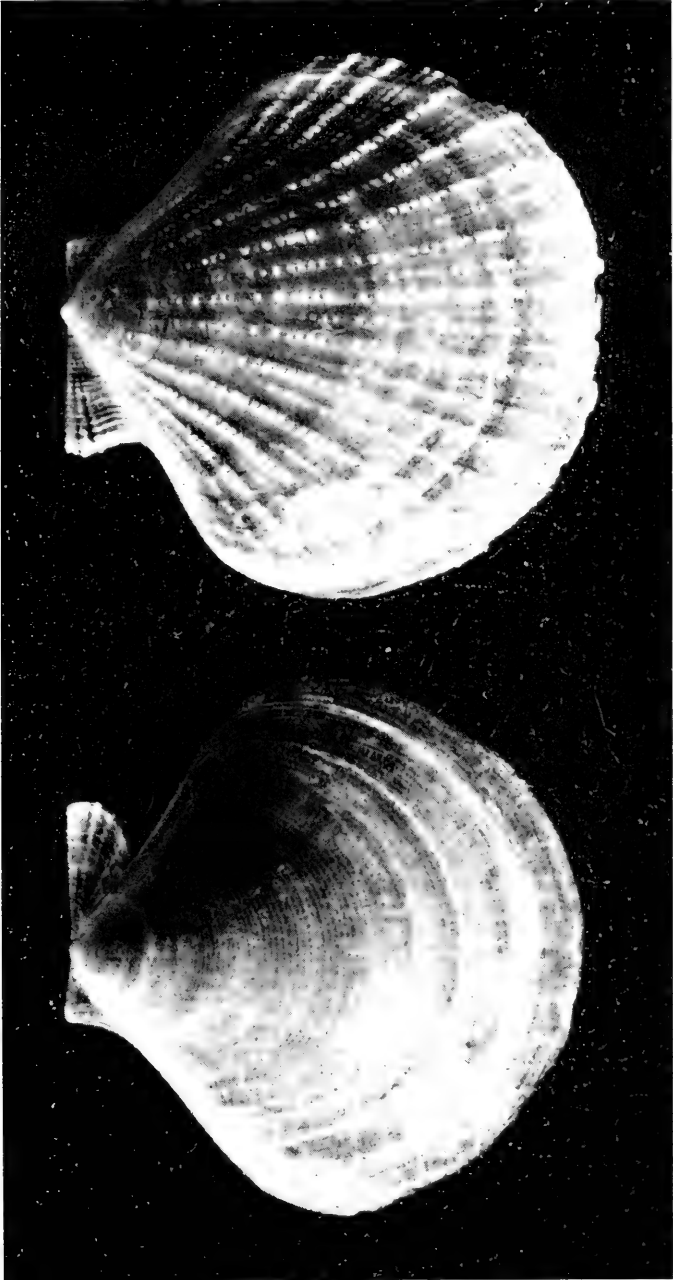


PLATE 5

Cyclopecten benthalis sp. nov. Holotype, Hancock expeditions station 3031-55, 14.5 miles NNW of San Nicolas Island, California, in 490 fathoms. Height: 8 mm; length: 7.5 mm. (Hancock Foundation collection.) P.

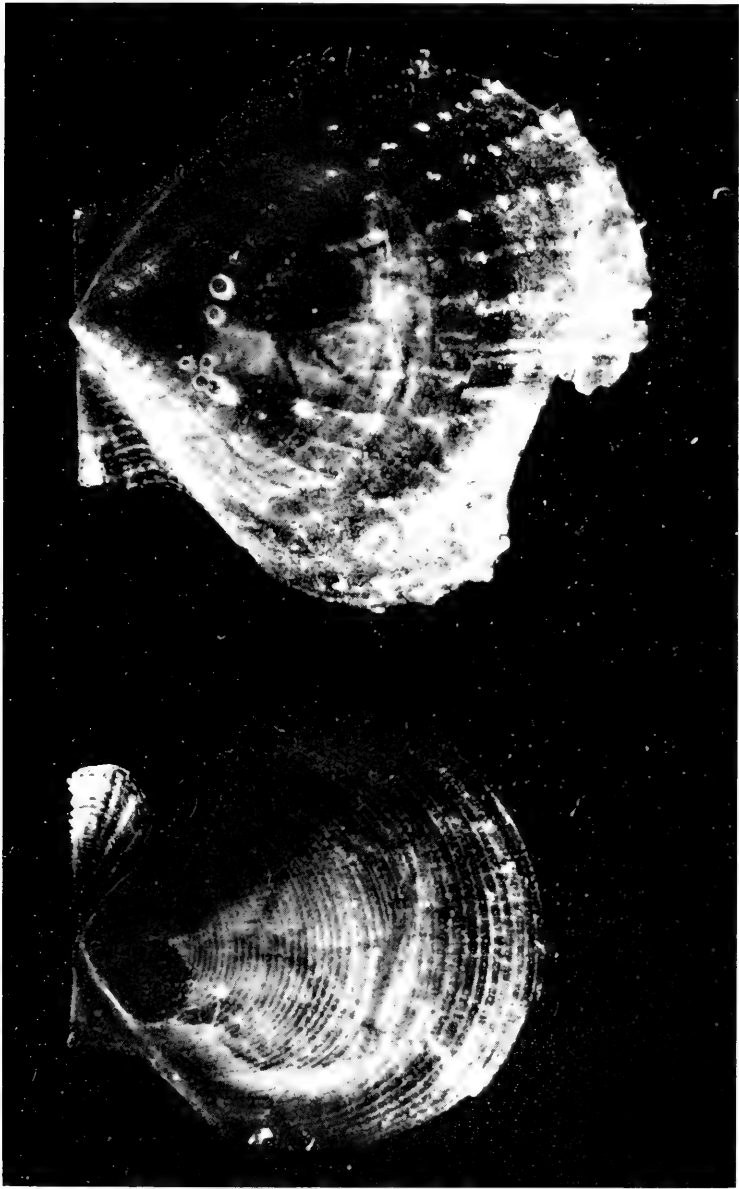


PLATE 6

Cyclopecten subhyalinus (E. A. Smith), 1885. Reproduction of original figures. *Challenger* station, 310, off southern Chile, in 400 fathoms. Height: 7.5 mm; length: 7 mm. P.

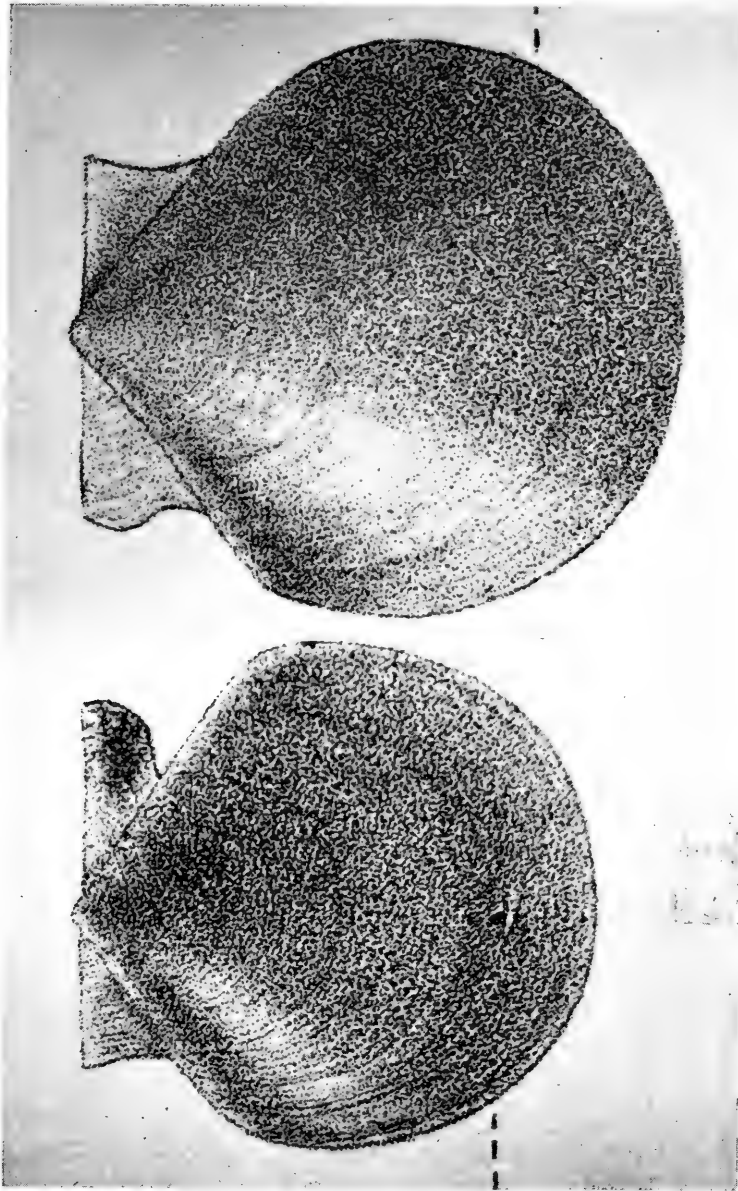


PLATE 7

- Fig. 1. *Cyclopecten zephyrus* sp. nov. Holotype. Hancock expeditions station 1613-48, off Santa Catalina Island, California, in 400-430 fathoms. Height and length: 9 mm. (Hancock Foundation collection.) P.
- Fig. 2. *Cyclopecten zephyrus* sp. nov. Paratype (same location; closed specimen). Height and length: 8.5 mm. (Grau collection.)
- Fig. 3. *Cyclopecten zephyrus* sp. nov. Single left valve showing commensal serpulid *Protis californica* Moore. Hancock expeditions station 2327-53, off Santa Catalina Island, California, in 490 fathoms. Height and length: 9 mm. (Grau collection.)

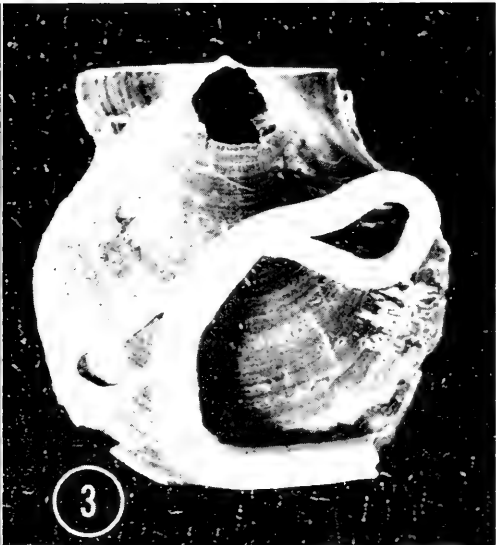
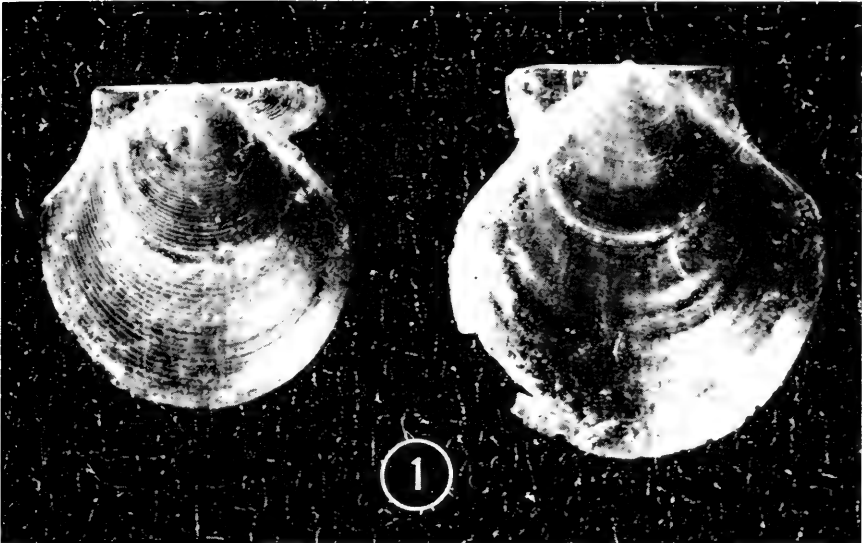


PLATE 8

- Fig. 1. *Cyclopecten liriopæ* (Dall), 1908. Lectotype. *Albatross* station 3392, Gulf of Panama, in 1270 fathoms. Height: 7.5 mm; length: 8 mm. (U.S. National Museum collection, no. 122869. Photograph by F. B. Kestner, U.S.N.M.) P.
- Fig. 2. *Cyclopecten bistriatus* (Dall), 1916. Paratype. U.S. Bur. Fish. station 2923, off San Diego, California, in 822 fathoms. Height and length: 7 mm. (U.S. National Museum collection, no. 609943. Photograph by F. B. Kestner, U.S.N.M.) P.

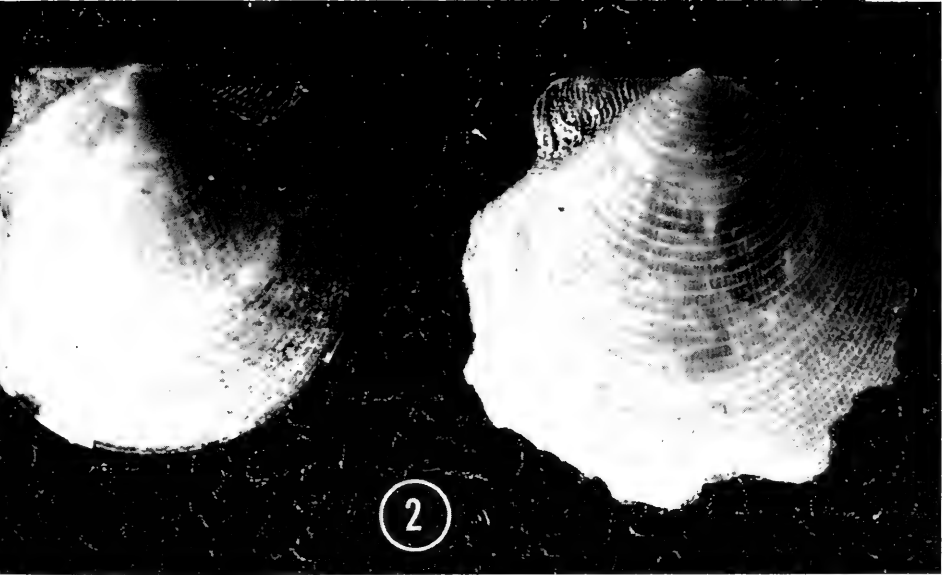
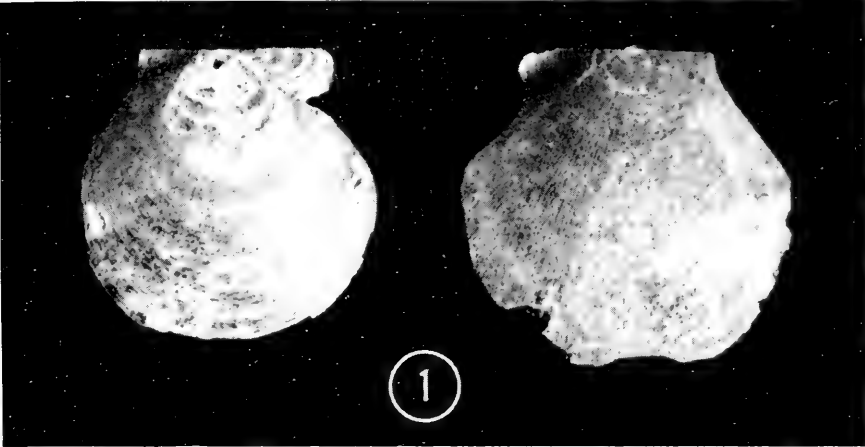


PLATE 9

- Fig. 1. *Cyclopecten catalinensis* (Willett), 1931. Hancock expeditions station 570-36, off Tiburon Island, Gulf of California, in 12 fathoms. Height and length: 10 mm. (Hancock Foundation collection. Photograph by R. V. George.) P.
- Fig. 2. *Cyclopecten cocosensis* (Dall), 1908. Lectotype. *Albatross* station 3369, off Cocos Island, Costa Rica, in 52 fathoms. Height: 8.7 mm; length: 9 mm. (U.S. National Museum collection, no. 122870. Photograph by F. B. Kestner, U.S.N.M.) P.

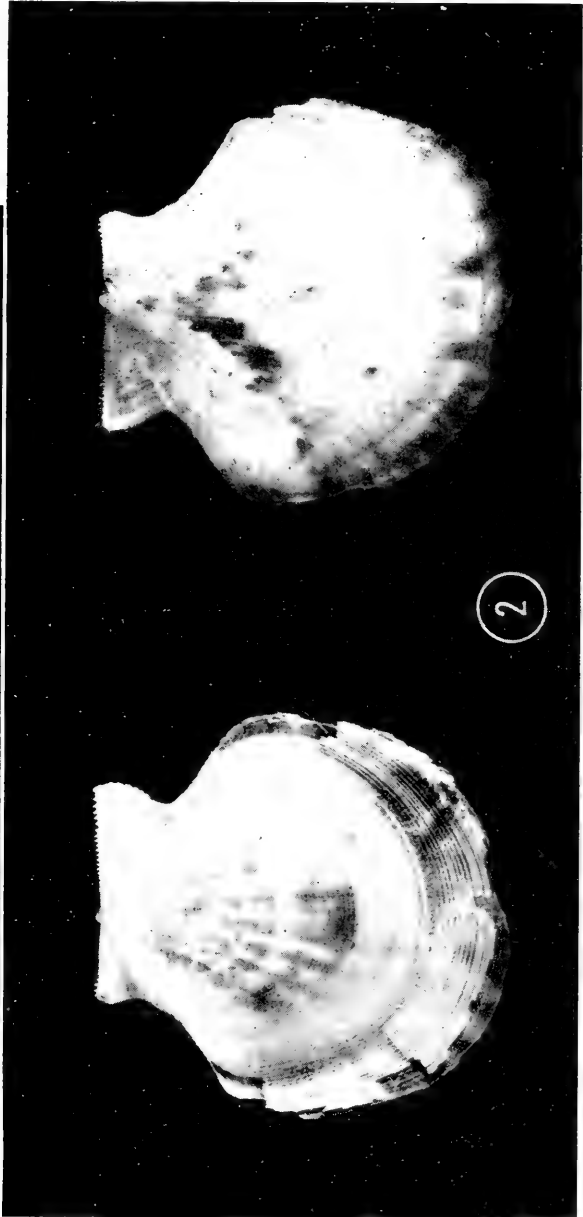
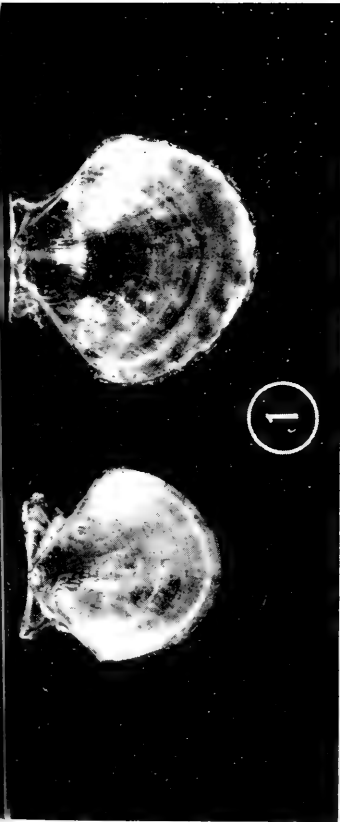


PLATE 10

- Fig. 1. *Pecten* (?var.) *squarrosus* Carpenter, 1865. Syntypes. " . . . 'Sta. Barbara.' Also and really Florida. . . ." Specimen on left: height: 46 mm; length: 45 mm; diameter: 12 mm. Specimen on right: height: 21 mm; length: 18 mm; diameter: 4.5 mm. (Redpath Museum collection; photographed there.) P.
- Fig. 2. *Cyclopecten acutus* sp. nov. Holotype. Hancock expeditions bottom sample 584, off Gorgona Island, west Colombia, in 32 fathoms. Height and length: 3.75 mm. (Hancock Foundation collection. Photograph by R. V. George.) P.

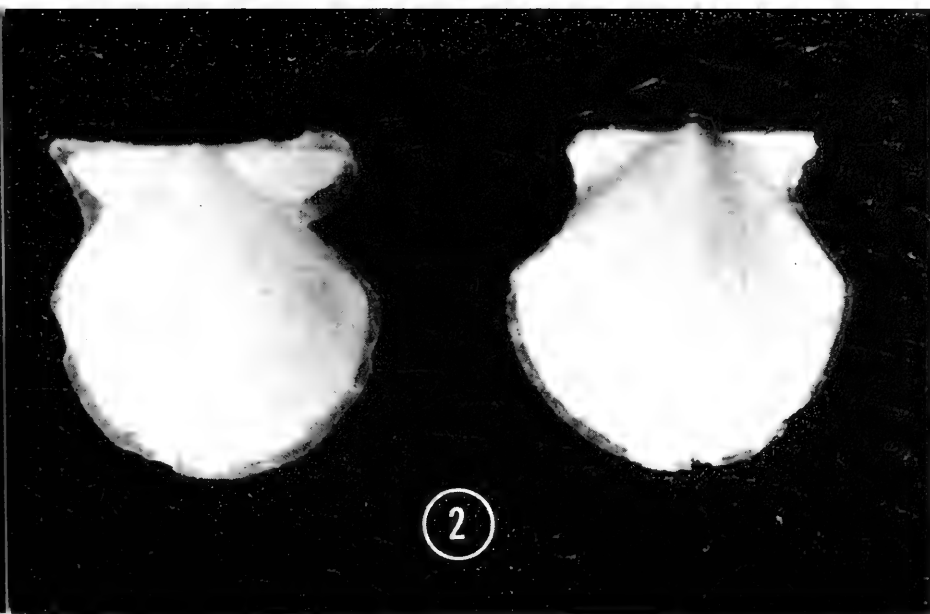
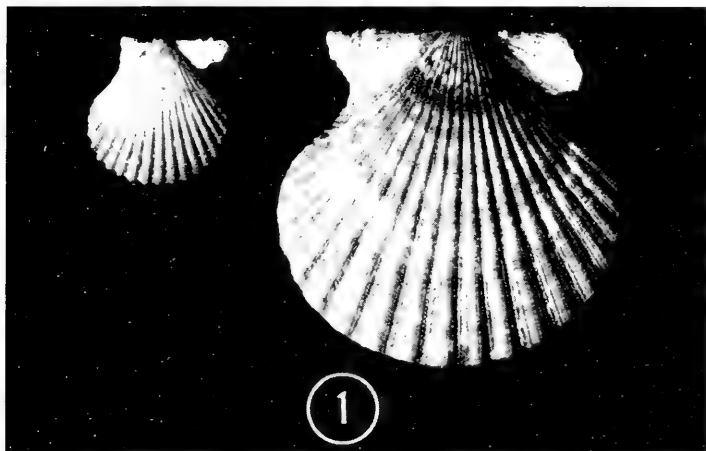


PLATE 11

Cyclopecten pernomus (Hertlein), 1935. Guadalupe Island, west Mexico. Height and length: 6 mm. (Grau collection.) P.



PLATE 12

Cyclopecten exquisitus sp. nov. Holotype. Hancock expeditions station 142-34, off Wenman Island, Galapagos Islands, in 100-150 fathoms. Height and length: 3.5 mm. (Hancock Foundation collection. Photograph by R. V. George.) P.

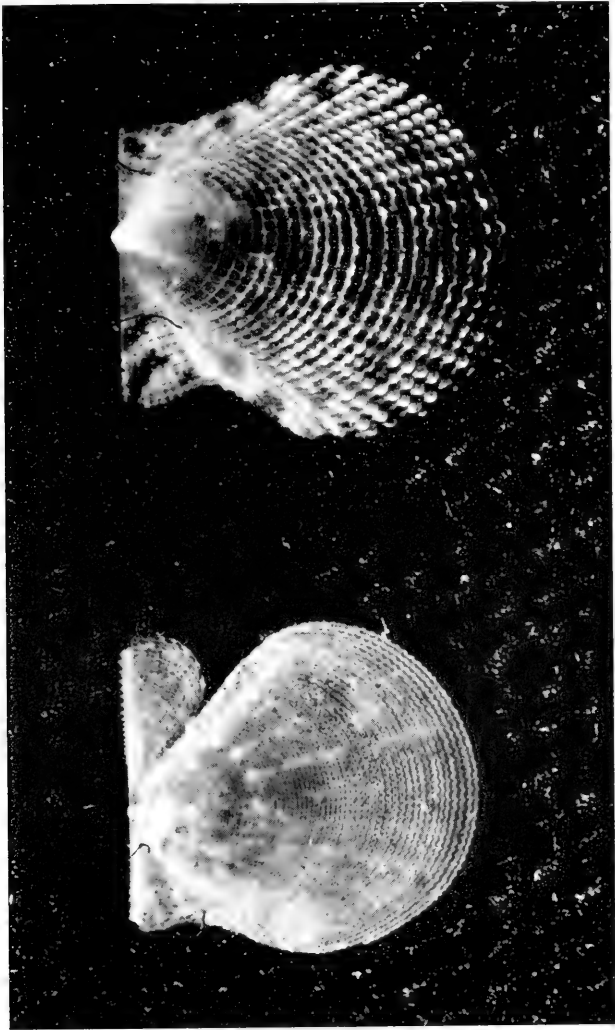


PLATE 13

Cyclopecten incongruus (Dall), 1916. Paratype. *Albatross* station 2986, NW of Cedros Island, Lower California, in 684 fathoms. Height: 14 mm; length: 15 mm. (U.S. National Museum collection, no. 609942.) P.

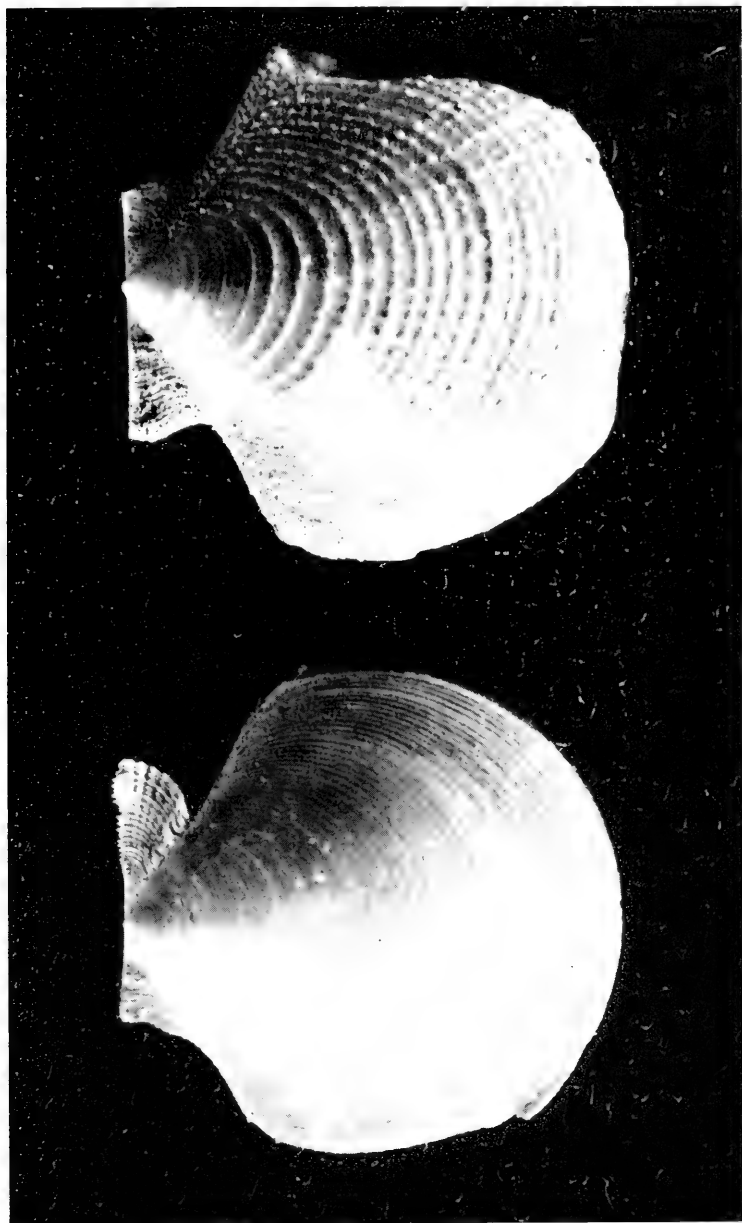


PLATE 14

- Fig. 1. *Cyclopecten barbarentis* sp. nov. Holotype. Hancock expeditions bottom sample 1064, off Santa Barbara Island, California, in 27 fathoms. Height and length: 3 mm. (Hancock Foundation collection.) P.
- Fig. 2. *Cyclopecten barbarentis* sp. nov. Paratype. Hancock expeditions bottom sample 1086, off San Nicolas Island, California, in 30 fathoms. Height: 4 mm; length: 4 mm. (Grau collection.)

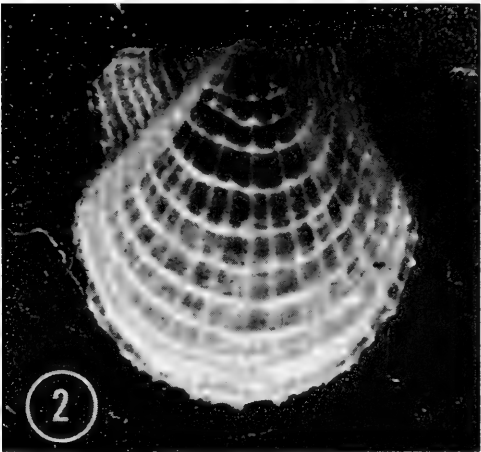
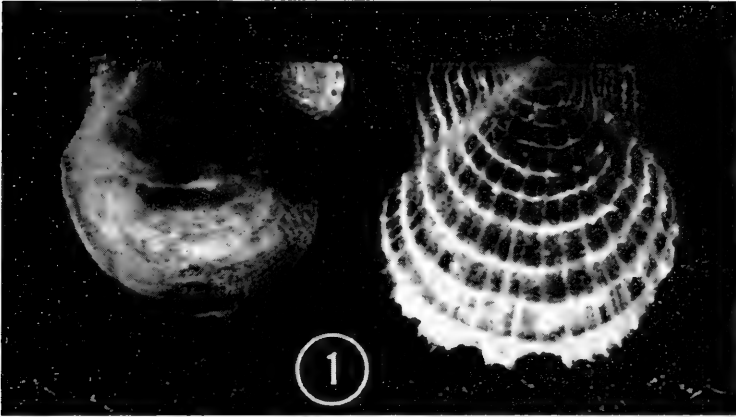


PLATE 15

Cyclopecten (*Delectopecten*) *vancouverensis* (Whiteaves), 1893.
Jervis Inlet, British Columbia, Canada, in 100 fathoms. Height
and length: 9 mm. (Grau collection.) P.

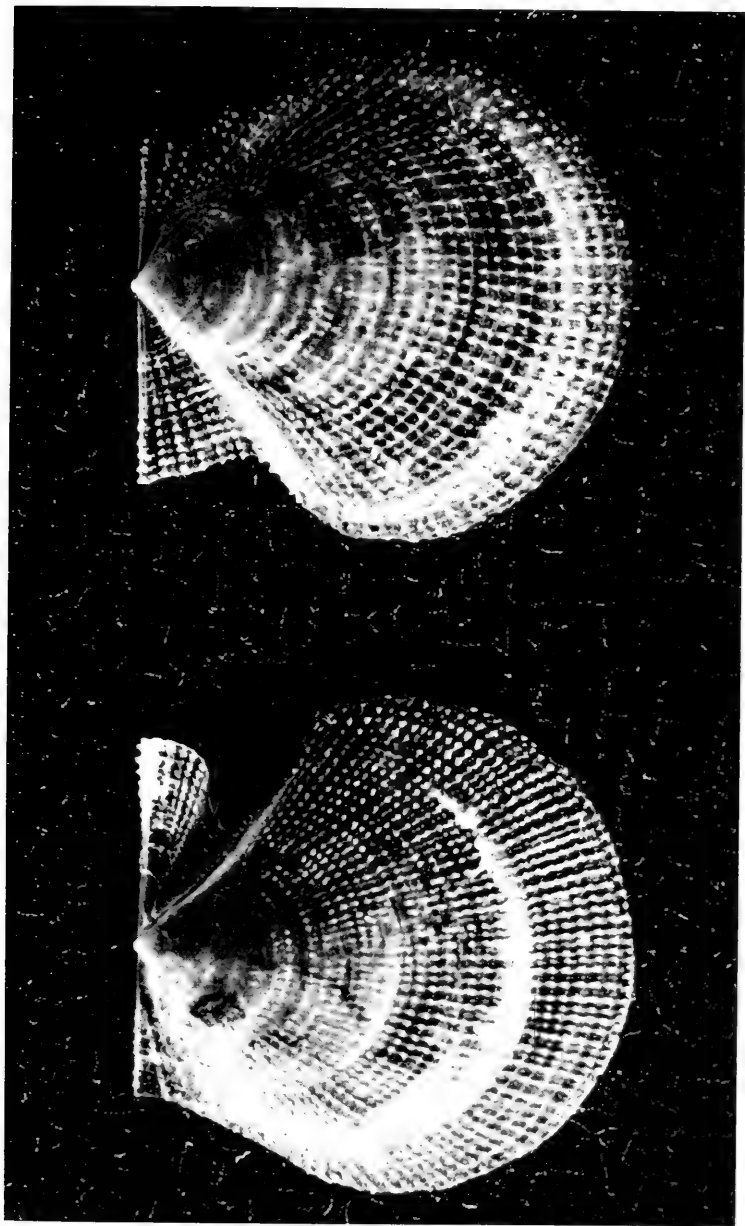


PLATE 16

- Fig. 1. *Cyclopecten (Delectopecten) polyleptus* (Dall), 1908. Holotype (single right valve). *Albatross* station 4642, off Hood Island, Galapagos Islands, in 300 fathoms. Height and length: 9.5 mm. (U.S. National Museum collection, no. 110586. Photograph by F. B. Kestner, U.S.N.M.) P.
- Figs. 2, 3. *Cyclopecten (Delectopecten) polyleptus* (Dall), 1908. Single left valves. *Albatross* station 2818, near Galapagos Islands, in 392 fathoms. (U.S. National Museum collection, no. 206395. Photograph by F. B. Kestner, U.S.N.M.)
- Fig. 4. *Cyclopecten (Delectopecten) randolphi* (Dall), 1897. Paratype. *Albatross* station 3343, off Destruction Island, Washington, in 516 fathoms. Height: 31 mm; length: 30 mm. (Grau collection.) P.
- Fig. 5. *Cyclopecten (Delectopecten) randolphi* (Dall), 1897. Labeled "*Pecten (Pseudamusium) whiteavesi* Dall" by I. S. Oldroyd. Scripps Institution of Oceanography station 1486 (1908), off San Diego, California, in 413 fathoms. Height and length: 30 mm. (Stanford Univ. Paleo. Type collection. Photographed there.)

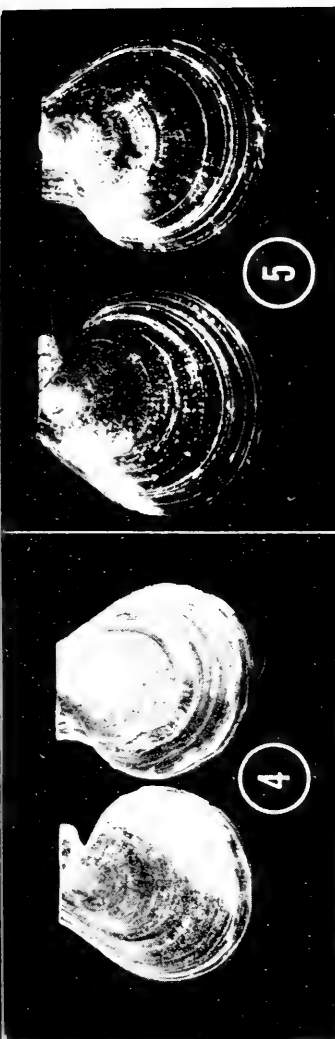
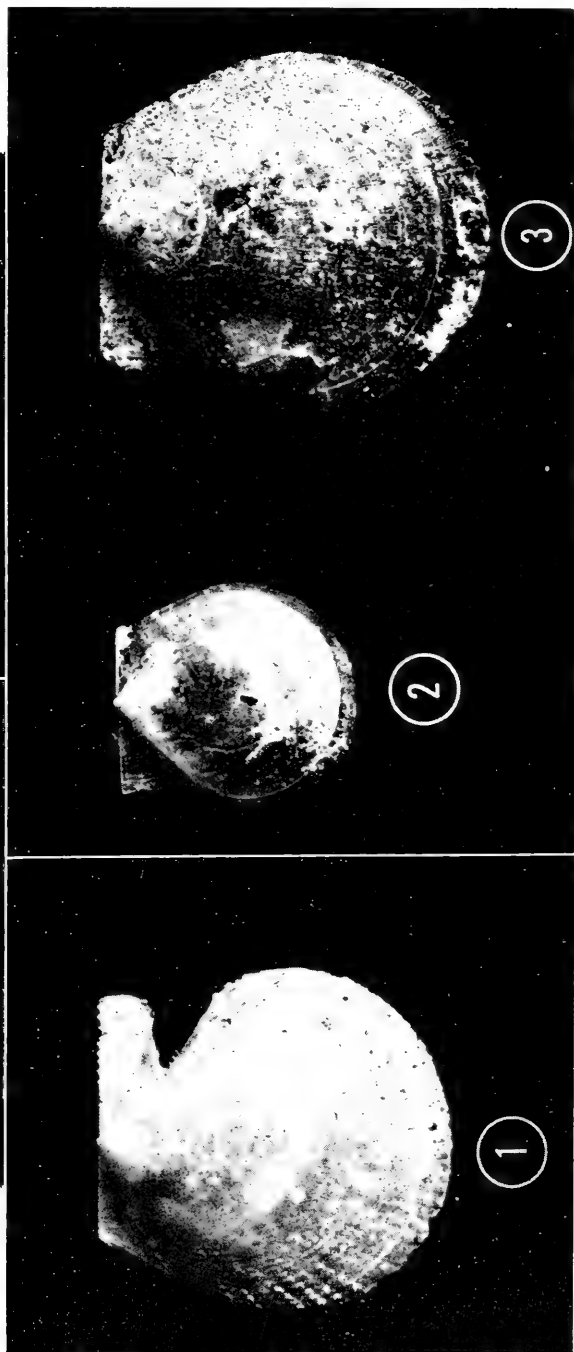


PLATE 17

Cyclopecten (Delectopecten) randolphi tillamookensis (Arnold), 1906. Paratype. *Albatross* station 4425, off Santa Barbara Island, California, in 1084-1100 fathoms. Height: 26 mm; length: 24 mm. (Grau collection.) P.

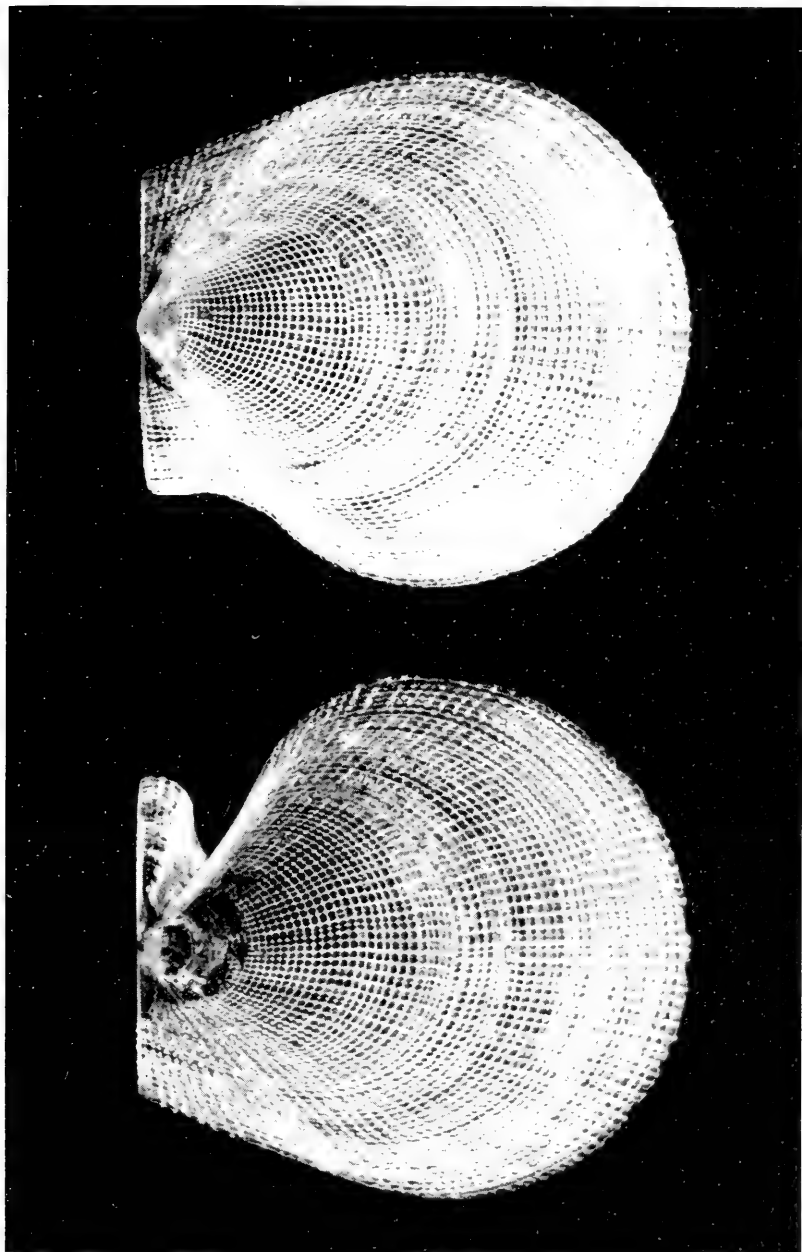


PLATE 18

Cyclopecten (Delectopecten) vitreus (Gmelin), 1791. Off Martha's Vineyard, Massachusetts, in 100-104 fathoms. A. E. Verrill leg., 18—? Height and length: 20.5 mm. (Grau collection.) P.

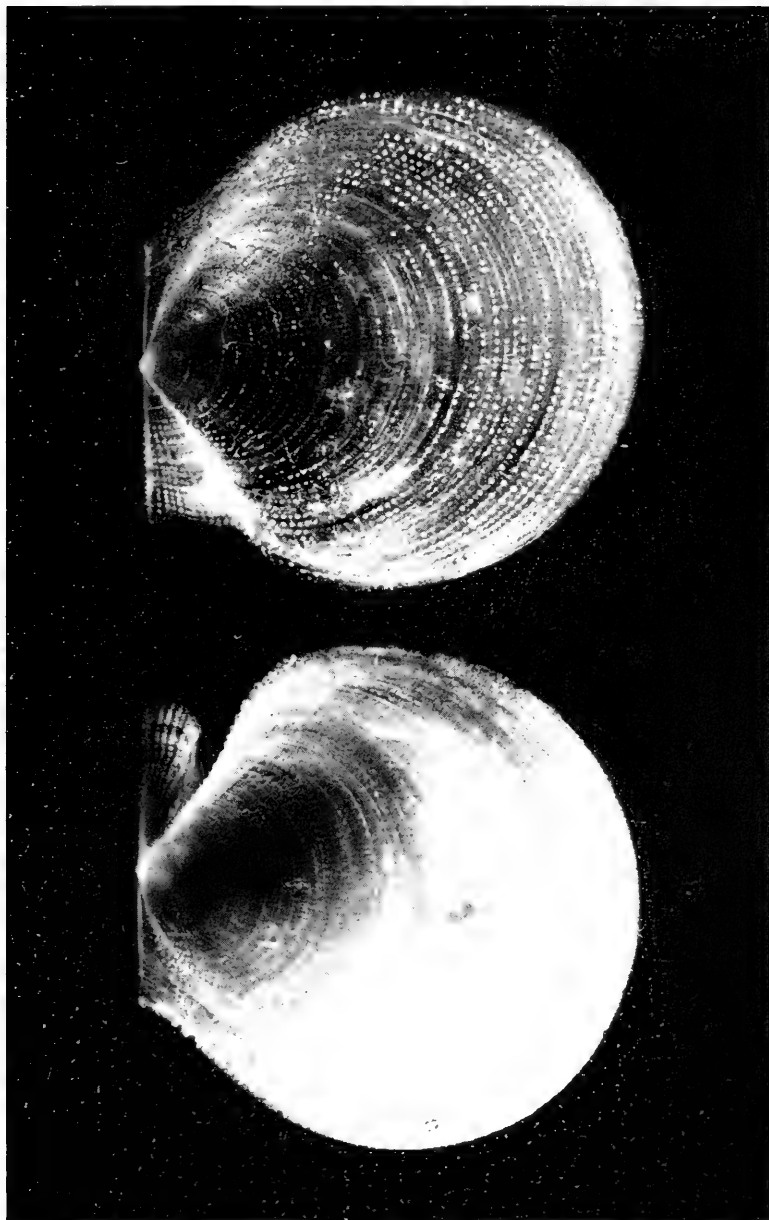


PLATE 19

Cyclopecten (Delectopecten) zaca (Hertlein), 1935. Hancock expeditions station 761-38, off Inner Gorda Bank, Gulf of California, in 345 fathoms. Height: 17 mm; length: 16 mm. (Hancock Foundation collection.) P.

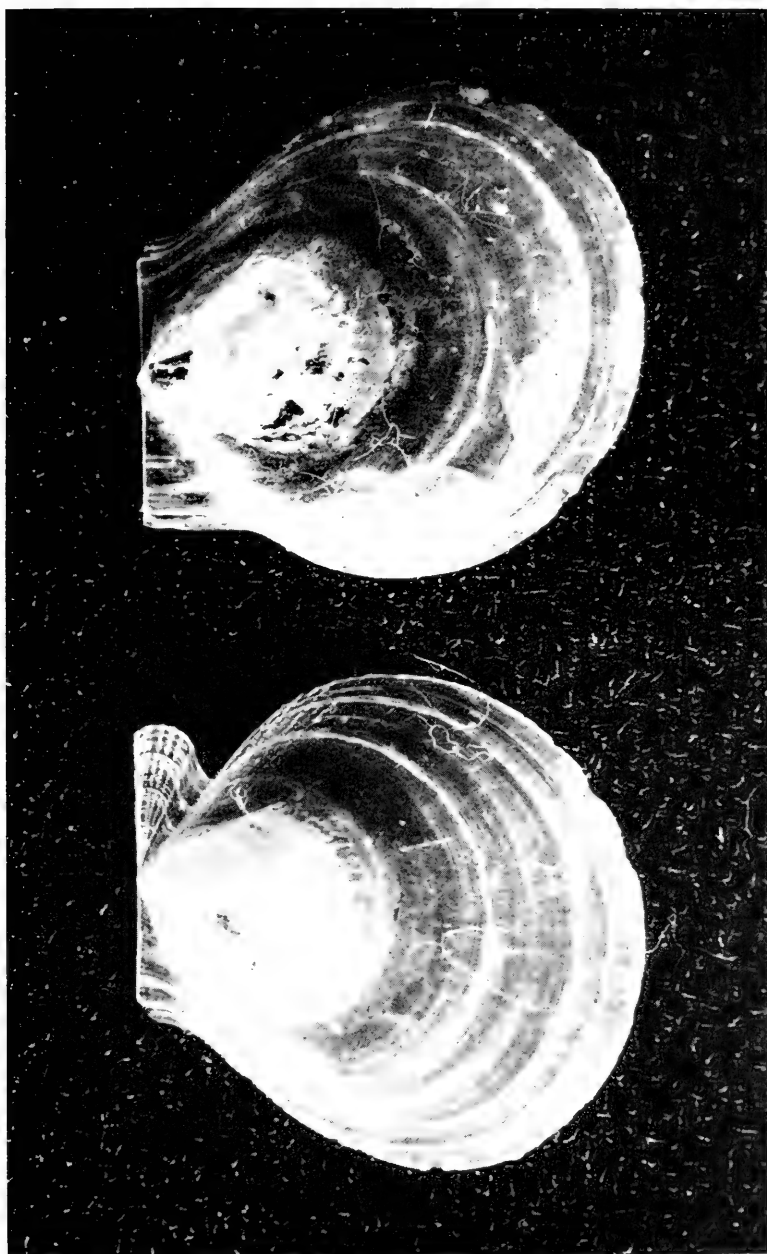


PLATE 20

Cyclopecten (*Delectopecten*) *greenlandicus* (Sowerby), 1842. Off Spitsbergen, Norway, in 100 fathoms. Spitsbergen Expedition leg., 1861. Height: 24 mm; length: 25 mm. (Grau collection.) P.

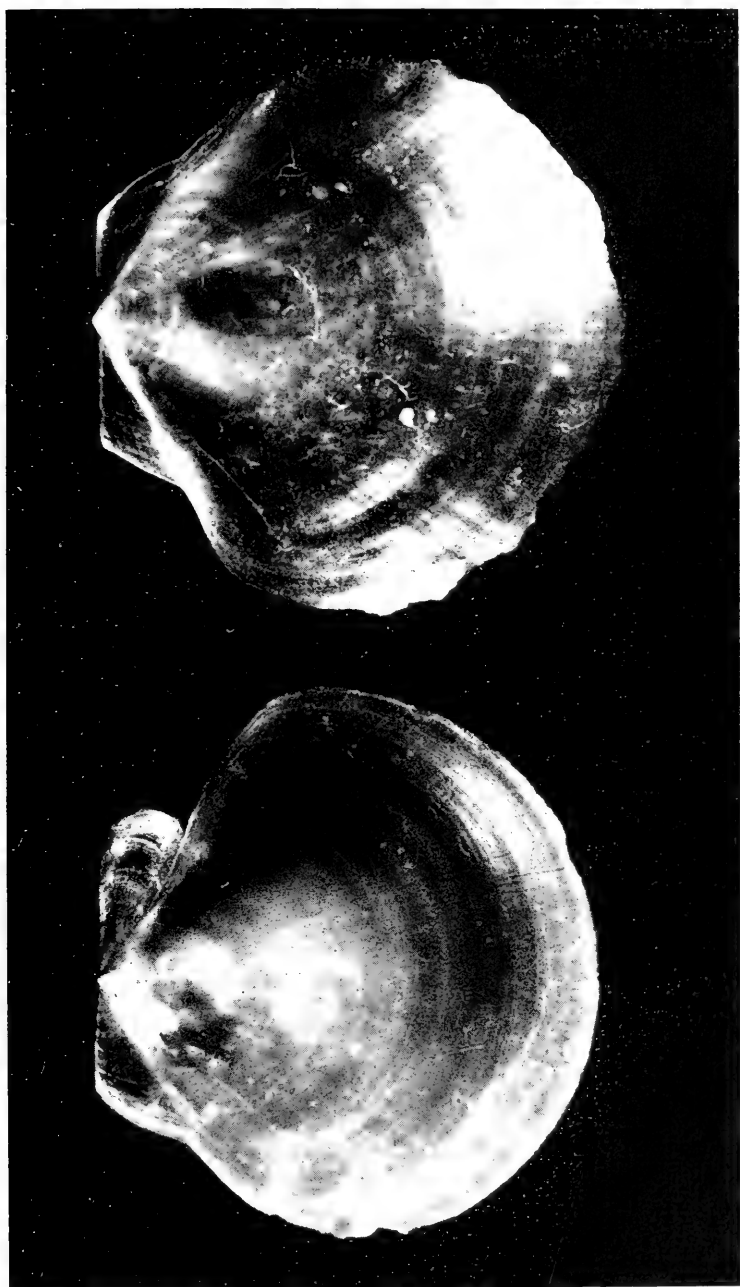


PLATE 21

Pseudamussium (Peplum) fasciculatum (Hinds), 1845. Inner Gorda Bank, Gulf of California, in 80 fathoms. Height: 27.5 mm; length: 26.5 mm. (Grau collection.) P.

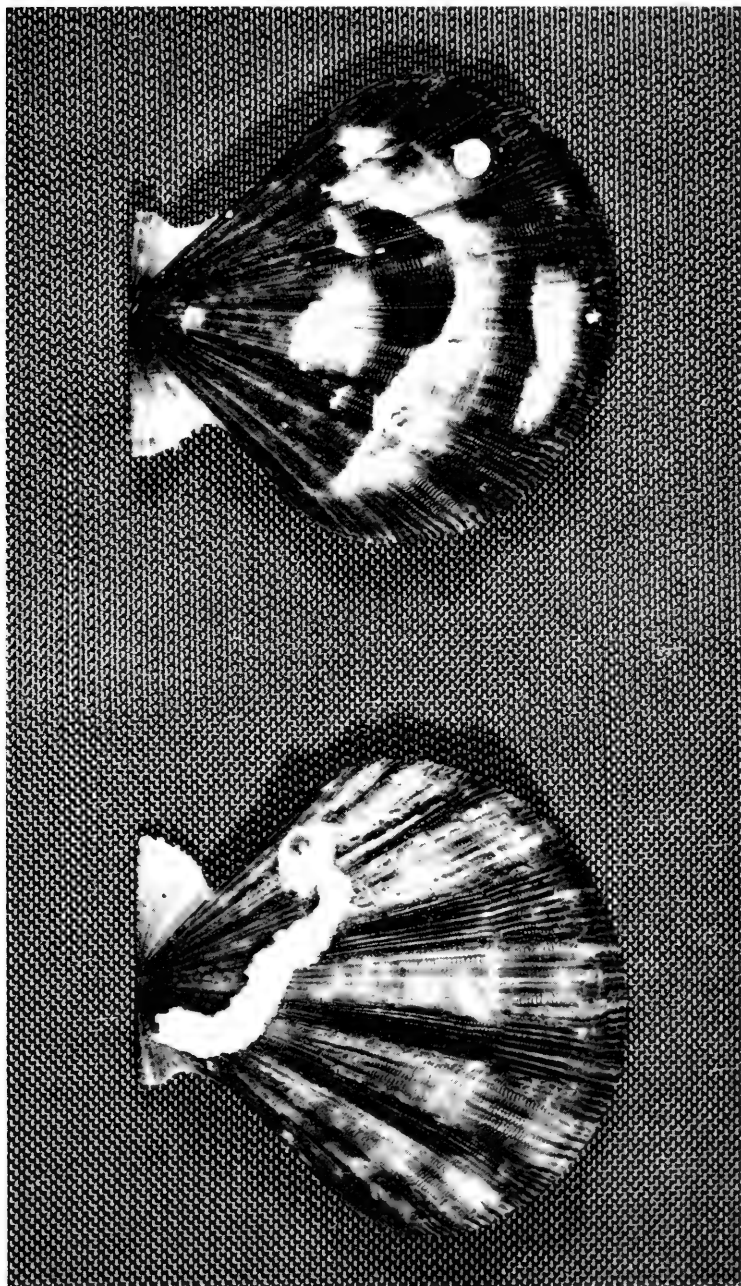


PLATE 22

Chlamys islandica (Müller), 1776. Off Godhavn, Greenland, in 65 fathoms. Height: 82 mm; length: 76 mm. (Grau collection.) P.

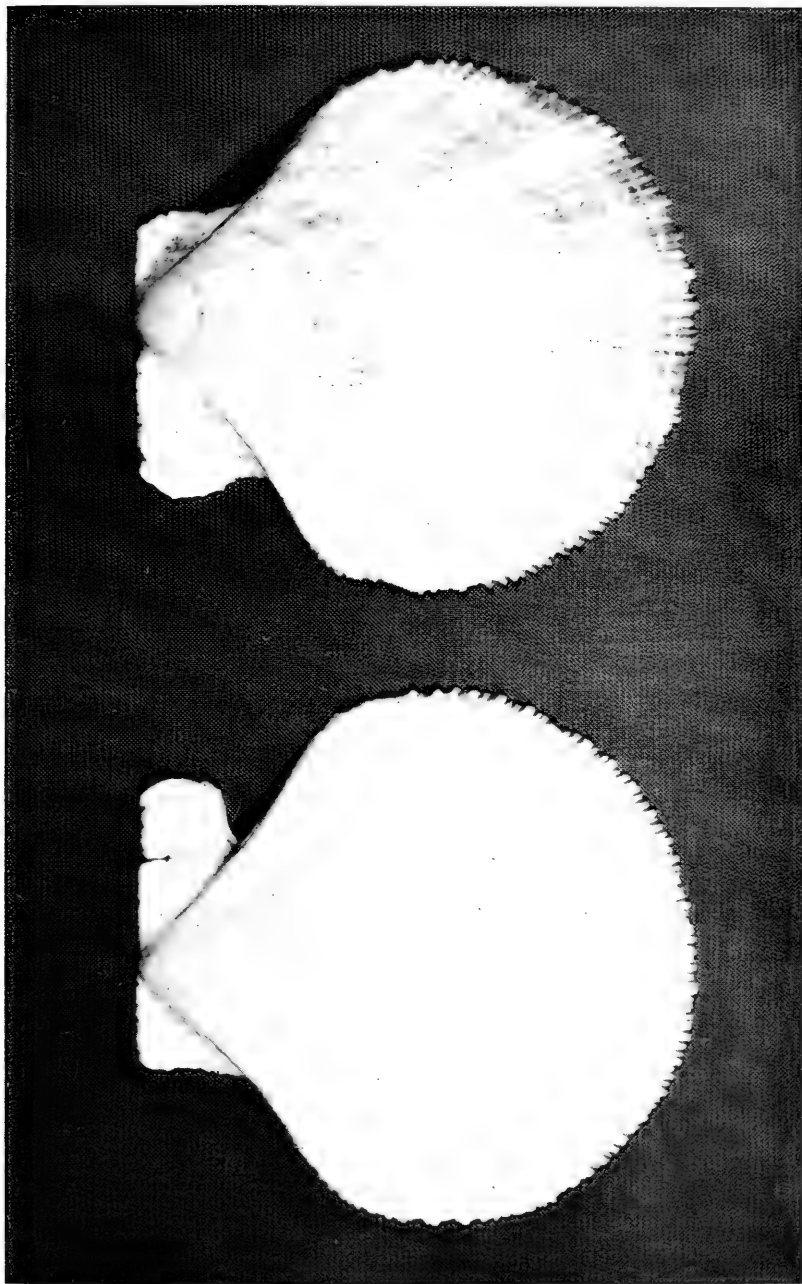


PLATE 23

- Fig. 1. *Chlamys islandica albida* (Dall in Arnold), 1906. Paratype. Albatross station 3322, off Markoffski Bay, Alaska, in 35 fathoms. Height: 46 mm; length: 41 mm. (Grau collection.) P.
- Fig. 2. *Chlamys islandica behringiana* (Middendorff), 1849. St. Paul Island, Pribilof Islands, Bering Sea. Height: 58 mm; length: 53 mm. (U.S. National Museum collection, no. 271731. Photograph by F. B. Kestner, U.S.N.M.) P.

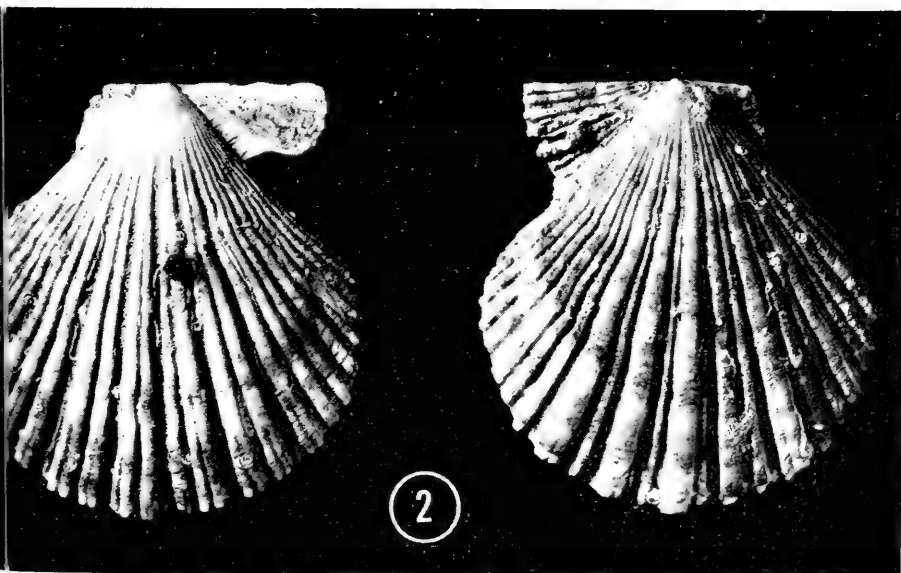
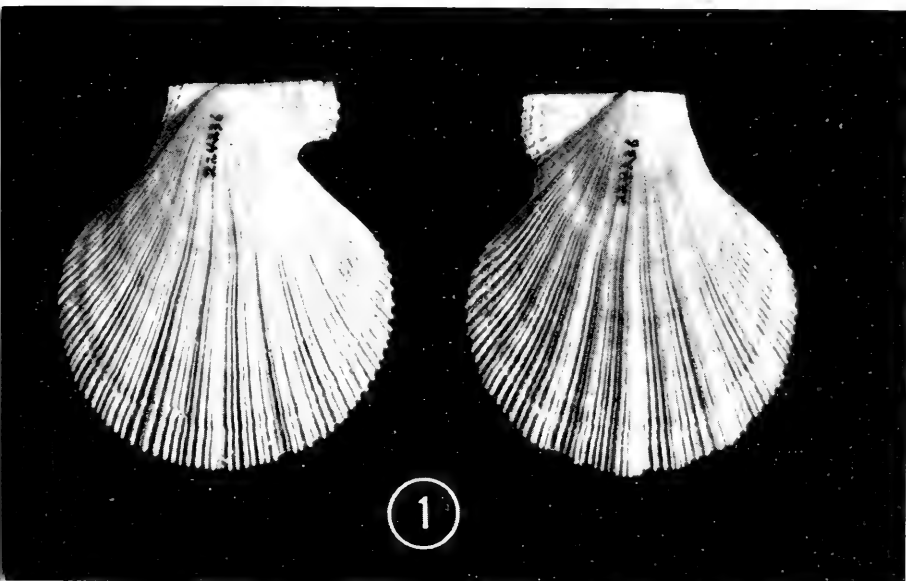


PLATE 24

Chlamys rubida (Hinds), 1864. San Juan Island, Washington, in 25 fathoms. Height and length: 59 mm. (Grau collection.) P.

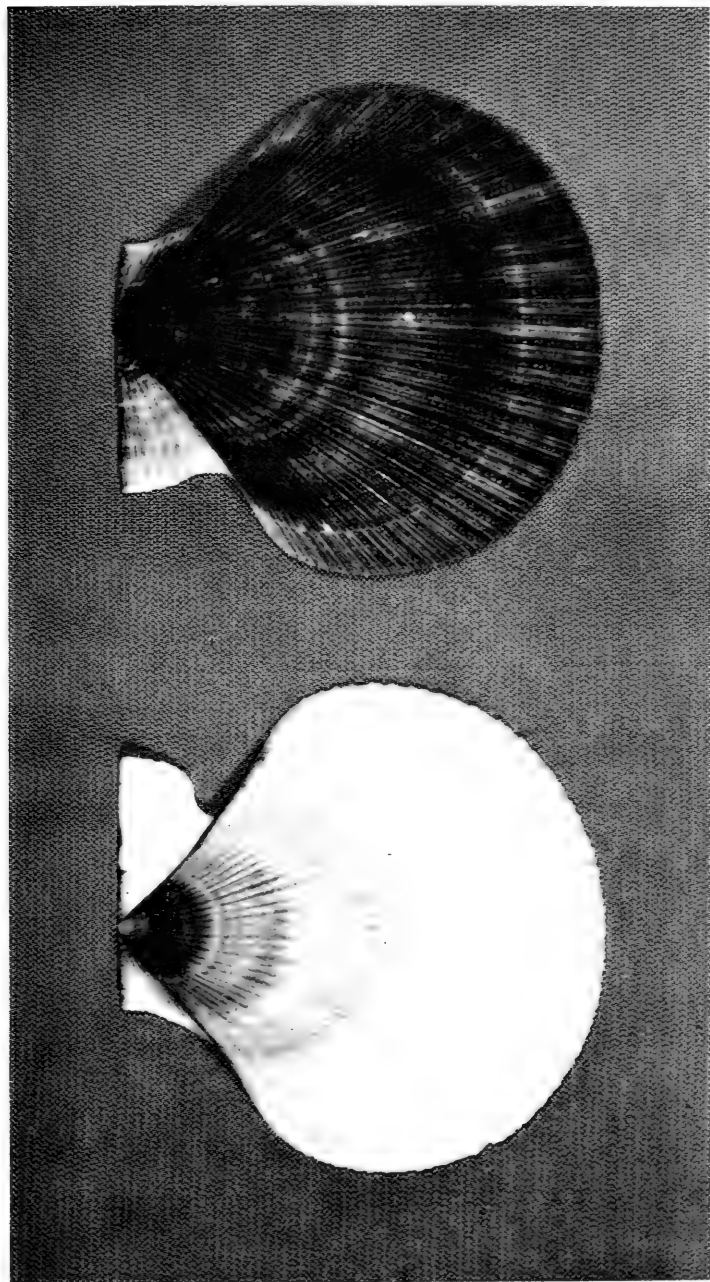


PLATE 25

Chlamys rubida jordani (Arnold), 1903. San Juan Island, Washington, in 20 fathoms. Height: 51 mm; length: 48 mm. (Grau collection.) P.

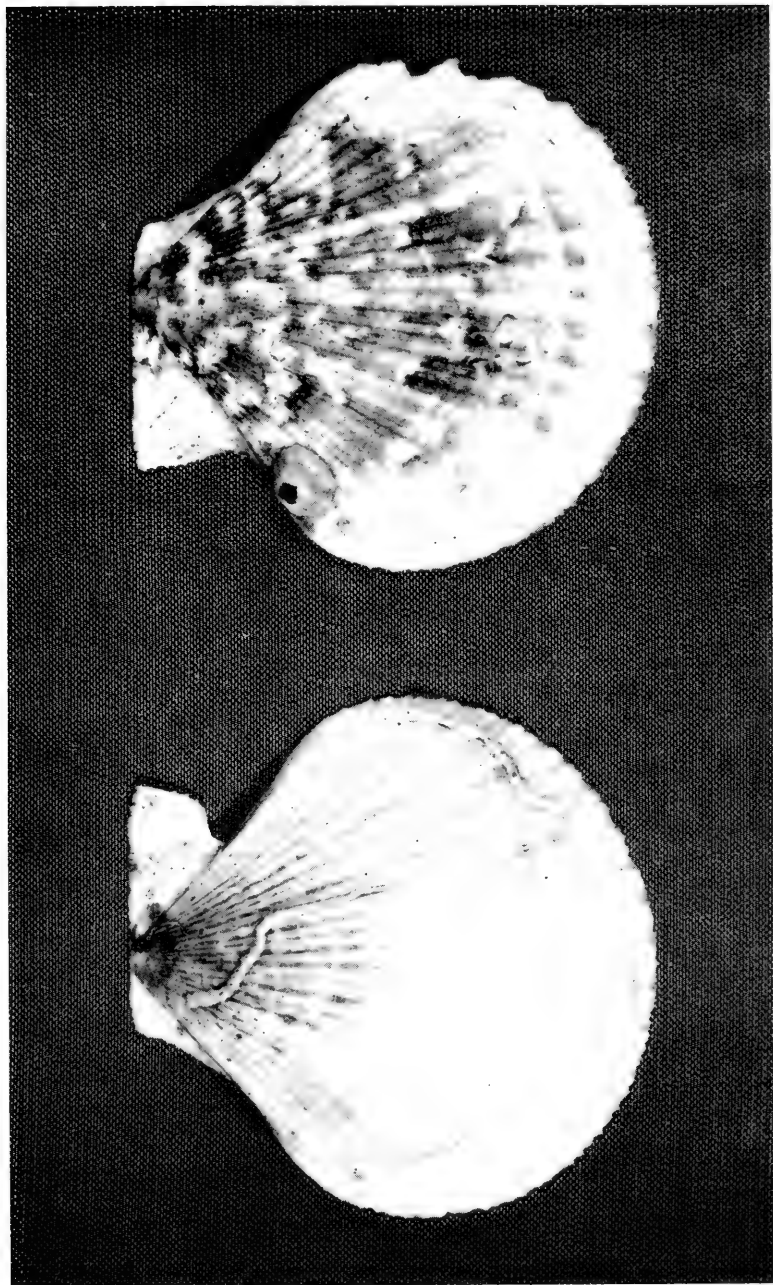


PLATE 26

Chlamys patagonica (King), 1831. Beagle Canal, Tierra del Fuego.
Height: 58 mm; length: 60 mm. (Grau collection.) P.

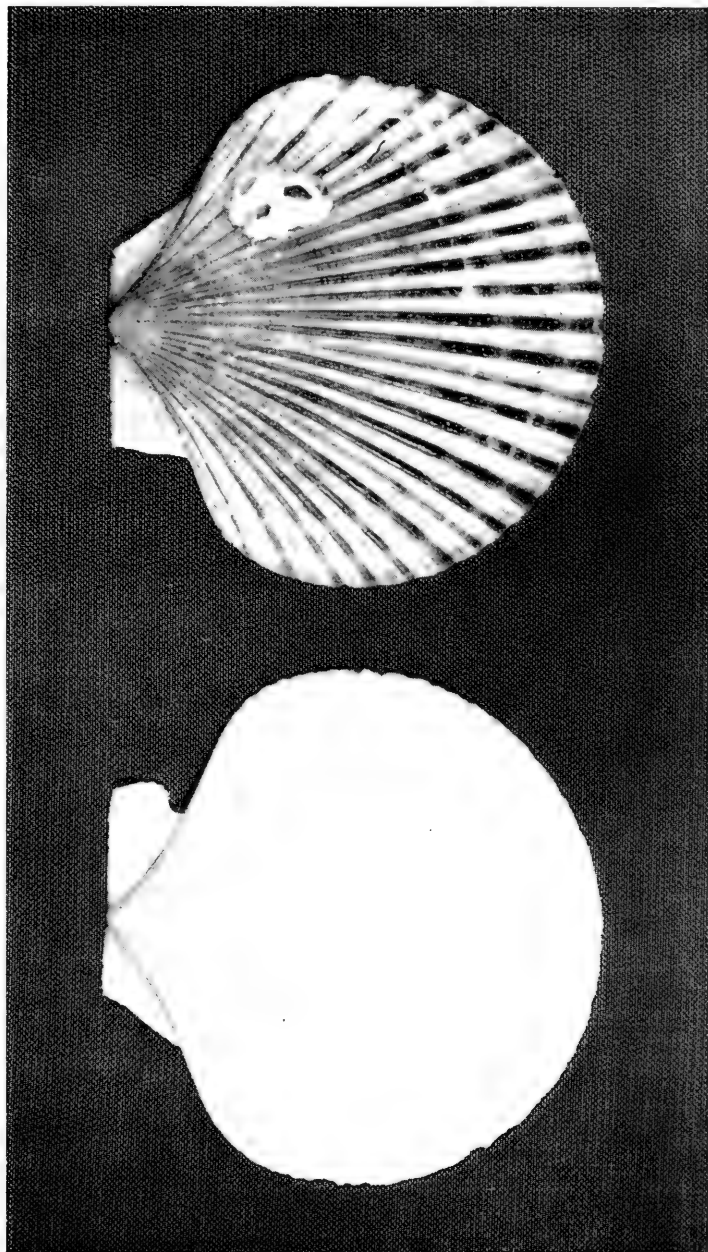


PLATE 27

Chlamys hastata (Sowerby), 1842. San Pedro, California, in 25 fathoms. Height: 56 mm; length: 53 mm. (Grau collection.) P.

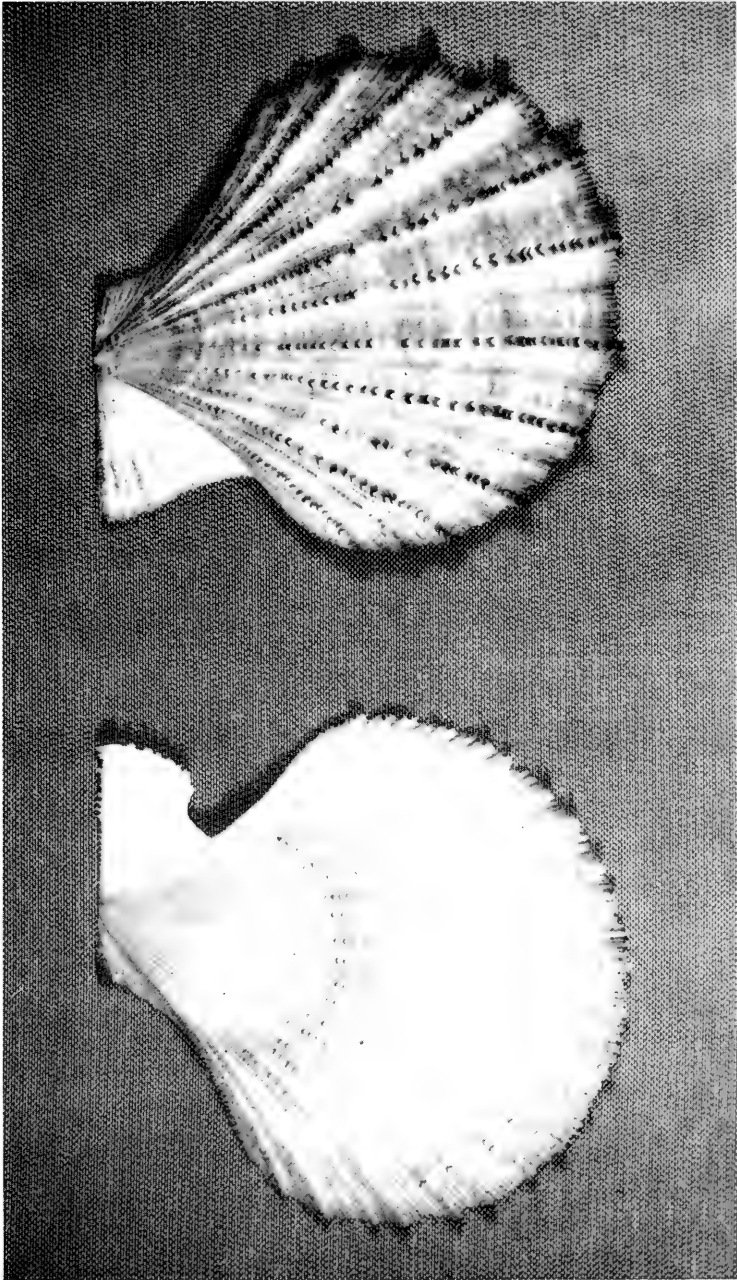


PLATE 28

Chlamys hastata (Sowerby), 1842. Very young specimen. Height: 7 mm; length: 6 mm. (Grau collection.) P.

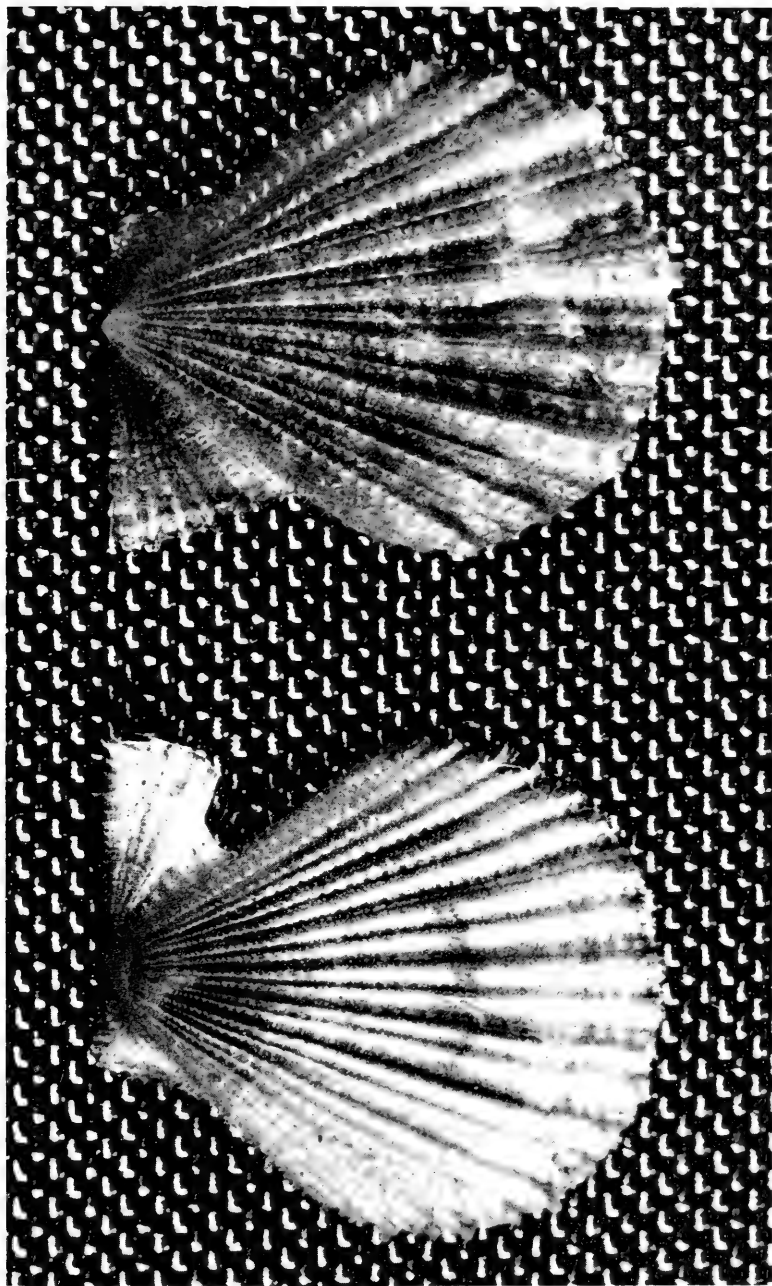


PLATE 29

Chlamys hastata hericia (Gould), 1850. Cadboro Bay, Vancouver Island, British Columbia, Canada, in 10 fathoms. Height and length: 63 mm. (Grau collection.) P.

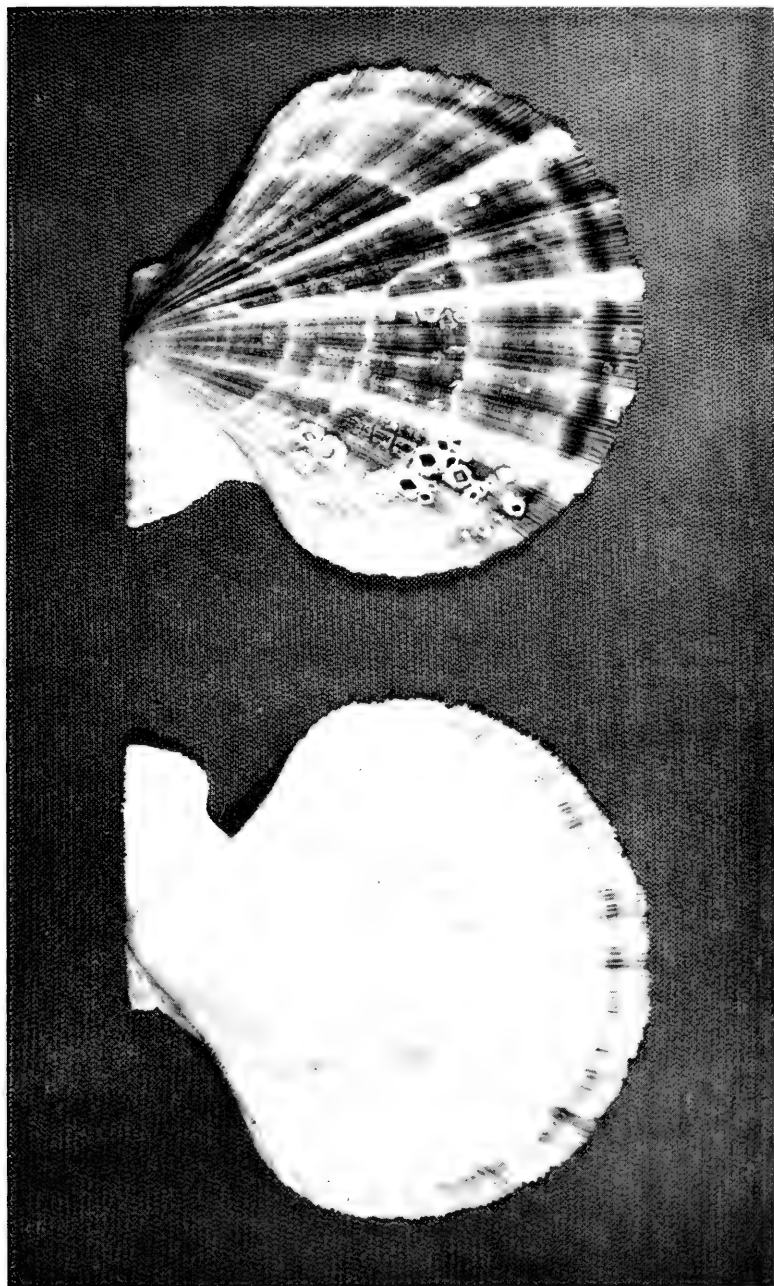


PLATE 30

Chlamys hastata pugetensis (Oldroyd), 1920. Cadboro Bay, Vancouver Island, British Columbia, Canada, in 10 fathoms. Height: 31.5 mm; length: 27 mm. (Grau collection.) P.

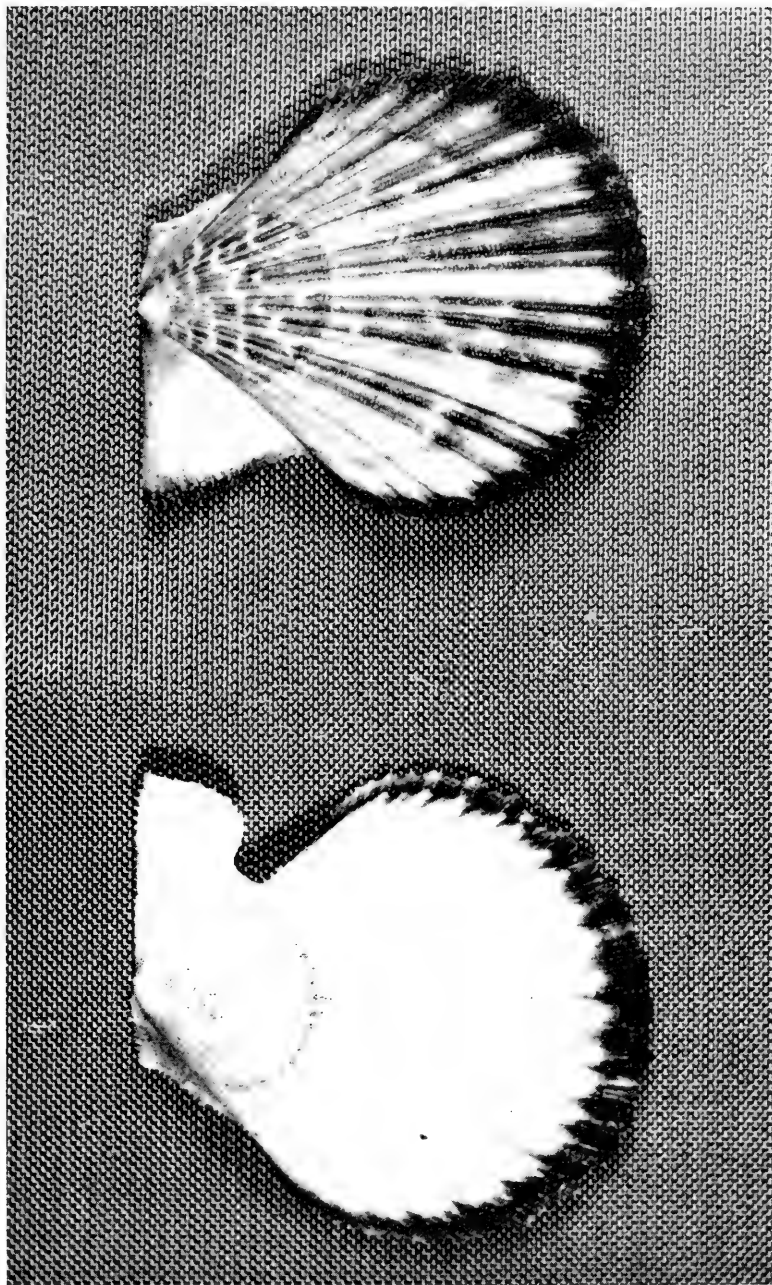


PLATE 31

Chlamys loweri (Hertlein), 1935. Las Animas Bay, Gulf of California, in 35 fathoms. Height: 18 mm; length: 15 mm. (Grau collection.) P.

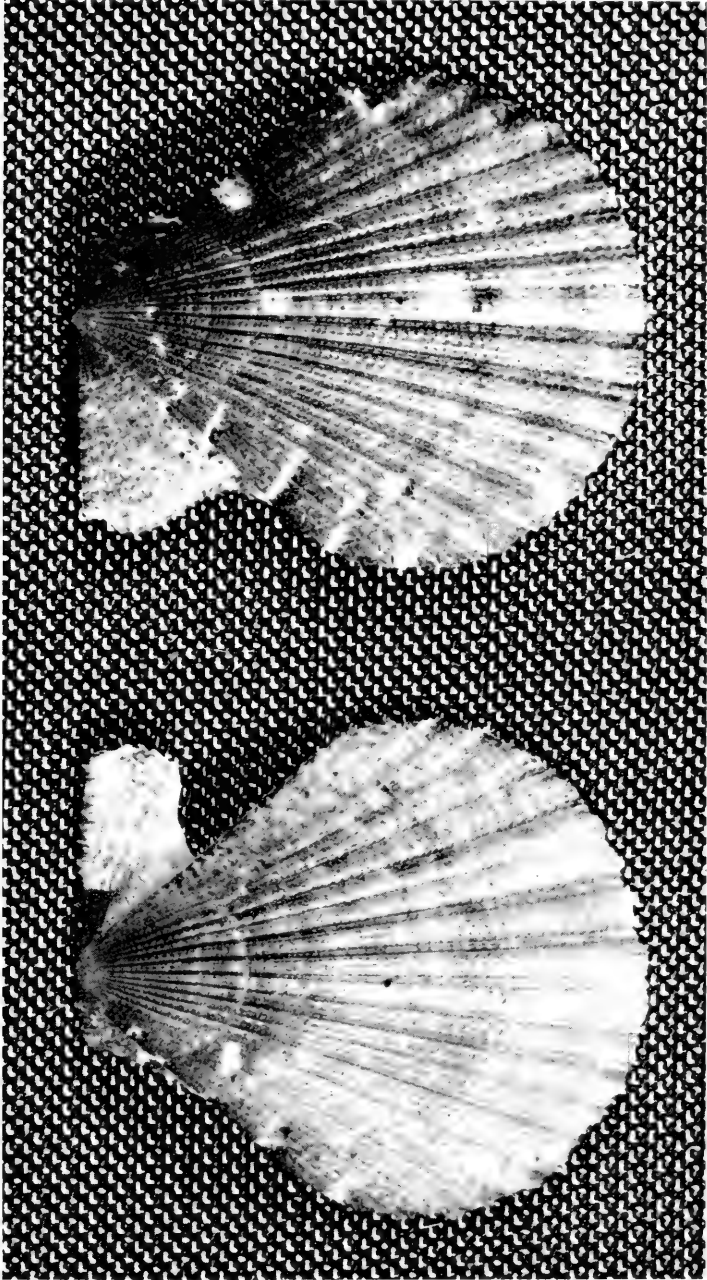


PLATE 32

Chlamys (Argopecten) circularis (Sowerby), 1835. La Paz, Lower California. Height: 66 mm; length: 73 mm. (Grau collection.) P.

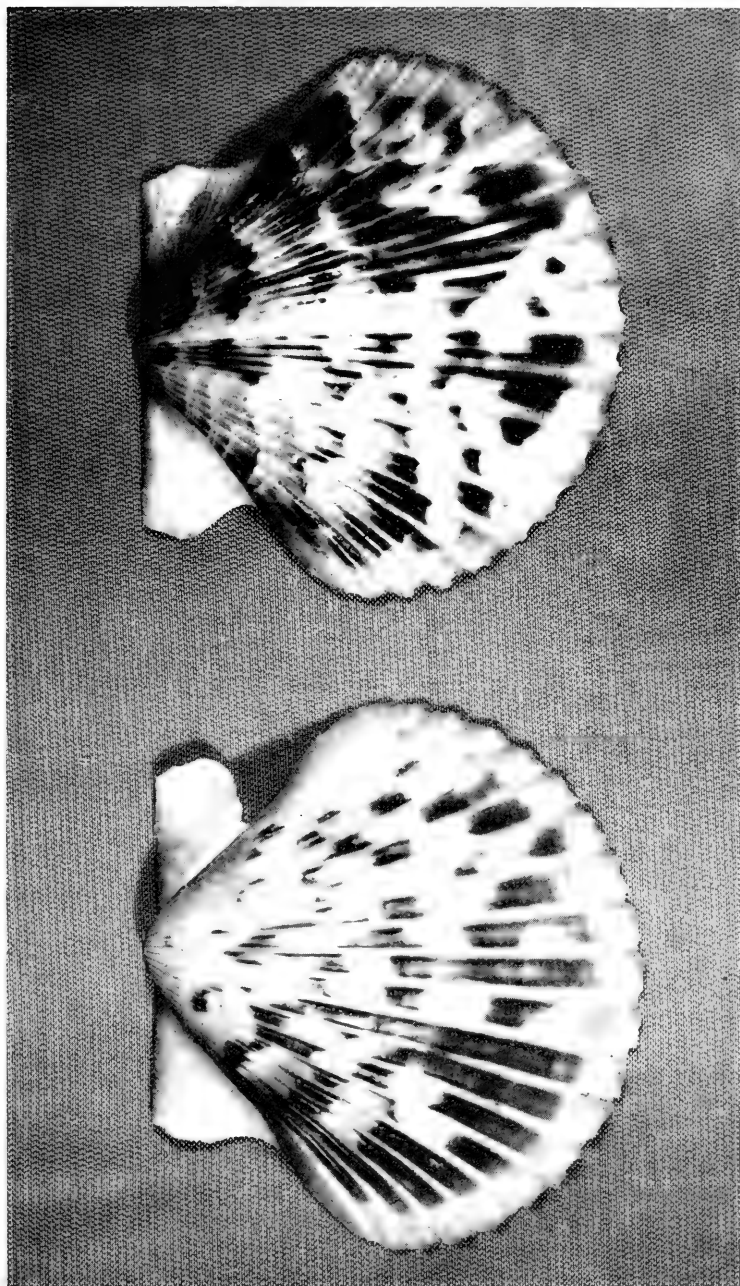


PLATE 33

Chlamys (Argopecten) circularis aequisulcata (Carpenter), 1864.
Newport Bay, California. Height: 65 mm; length: 68 mm. (Grau
collection.) P.

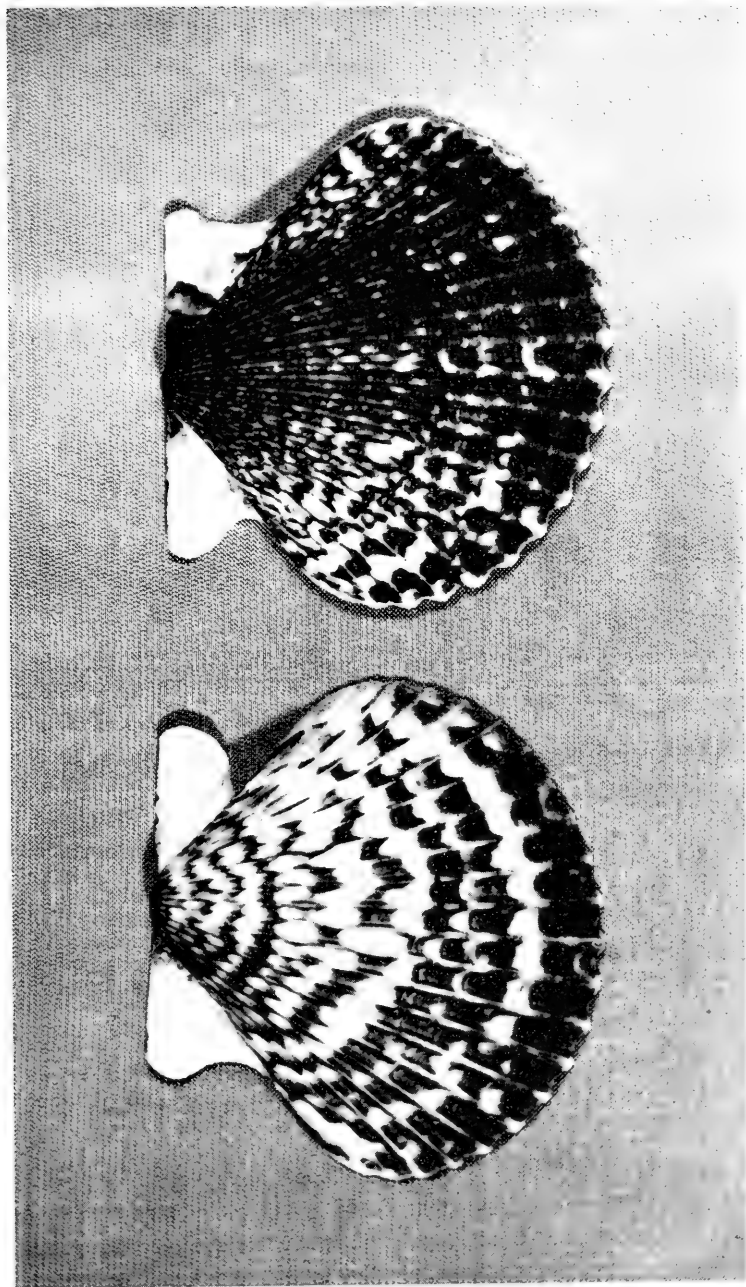


PLATE 34

Chlamys (Argopecten) purpurata (Lamarck), 1819. Tongoy, Coquimbo Province, Chile. Height: 97 mm; length: 106 mm. (Grau collection.) P.

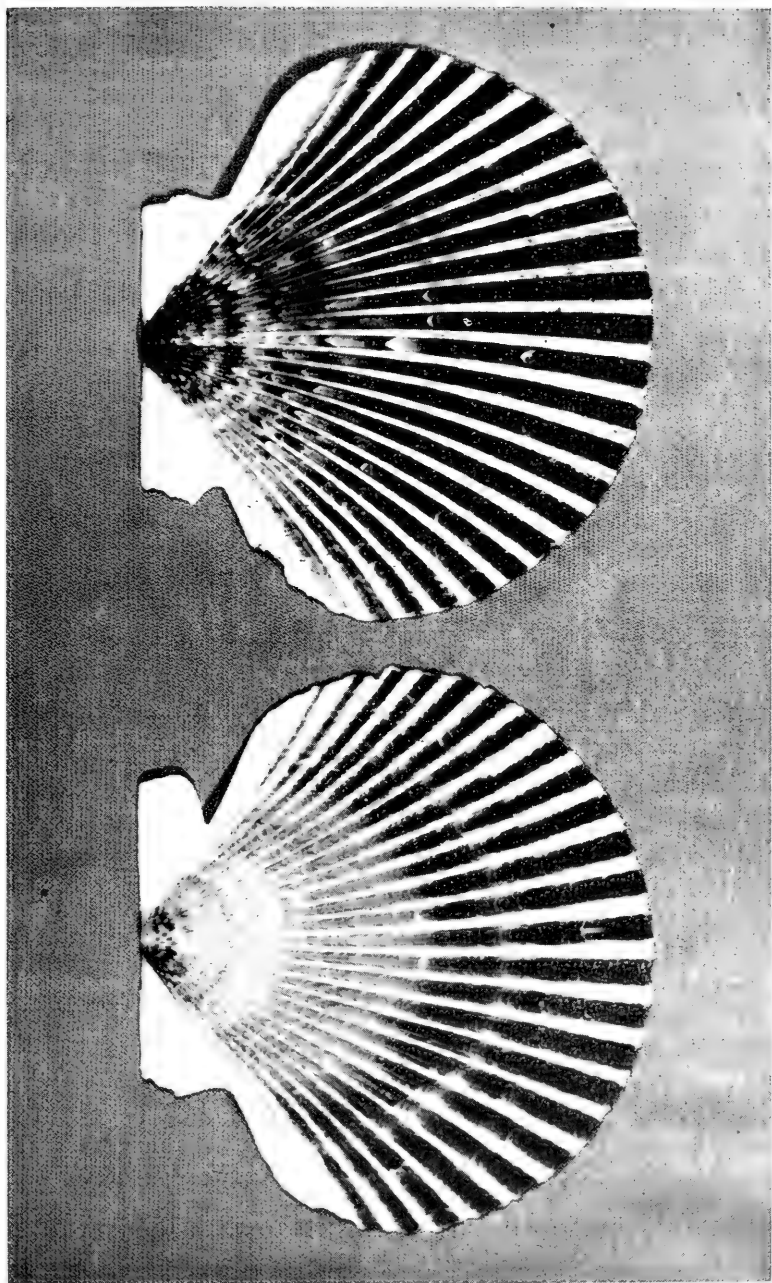


PLATE 35

- Fig. 1. *Chlamys (Leptopecten) latiaurata* (Conrad), 1837. Laguna Beach, California. Height: 18 mm; length: 20 mm. (Grau collection.) P.
- Fig. 2. *Chlamys (Leptopecten) latiaurata monotimeris* (Conrad), 1837. San Pedro, California. Height and length: 24 mm. (Grau collection.)

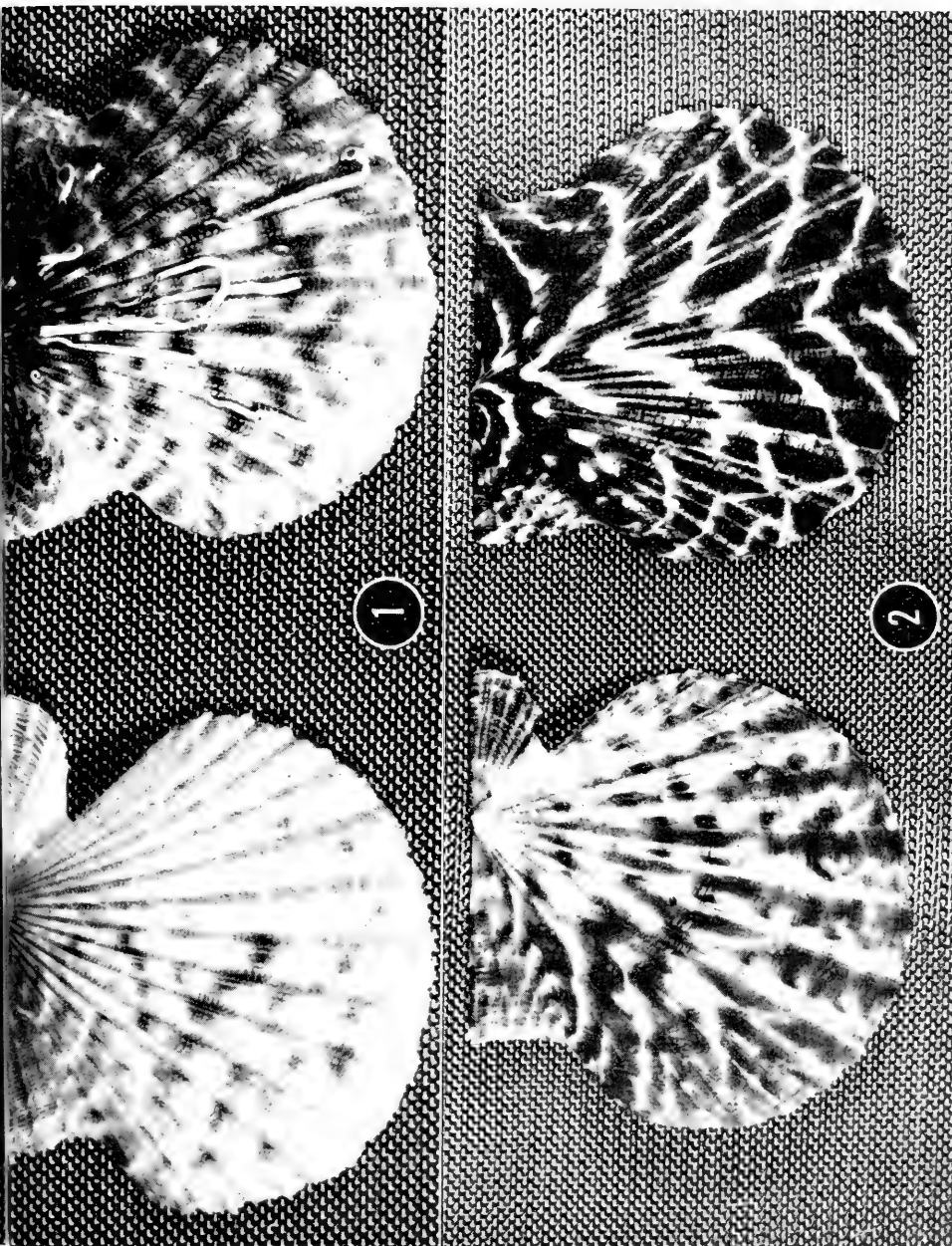


PLATE 36

Chlamys (Leptopecten) palmeri (Dall), 1897. Off Guaymas, Sonora, Mexico (Gulf of California), in 40 fathoms. Height: 38 mm; length: 39 mm. (Grau collection.) P.

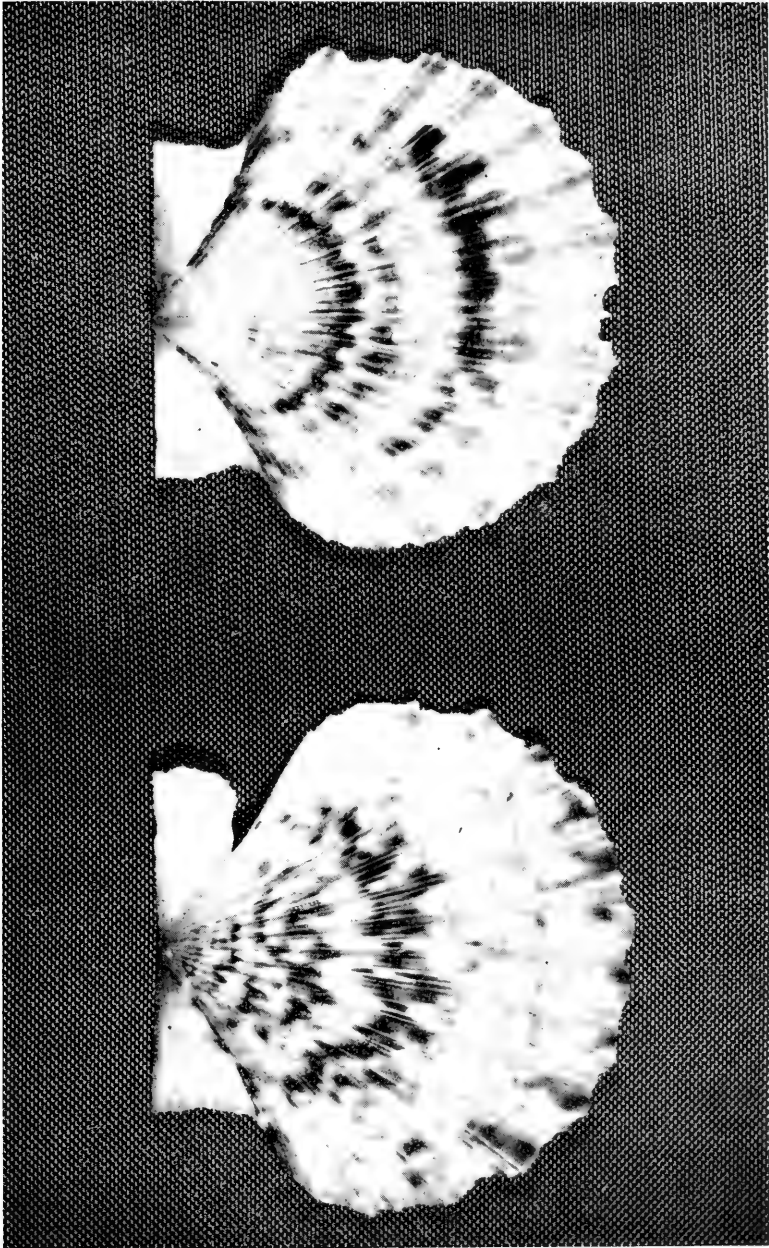


PLATE 37

Chlamys (Leptopecten) velero (Hertlein), 1935. Off Port Parker, Costa Rica, in 10 fathoms. Height: 11 mm; length: 12 mm. (Grau collection.) P.

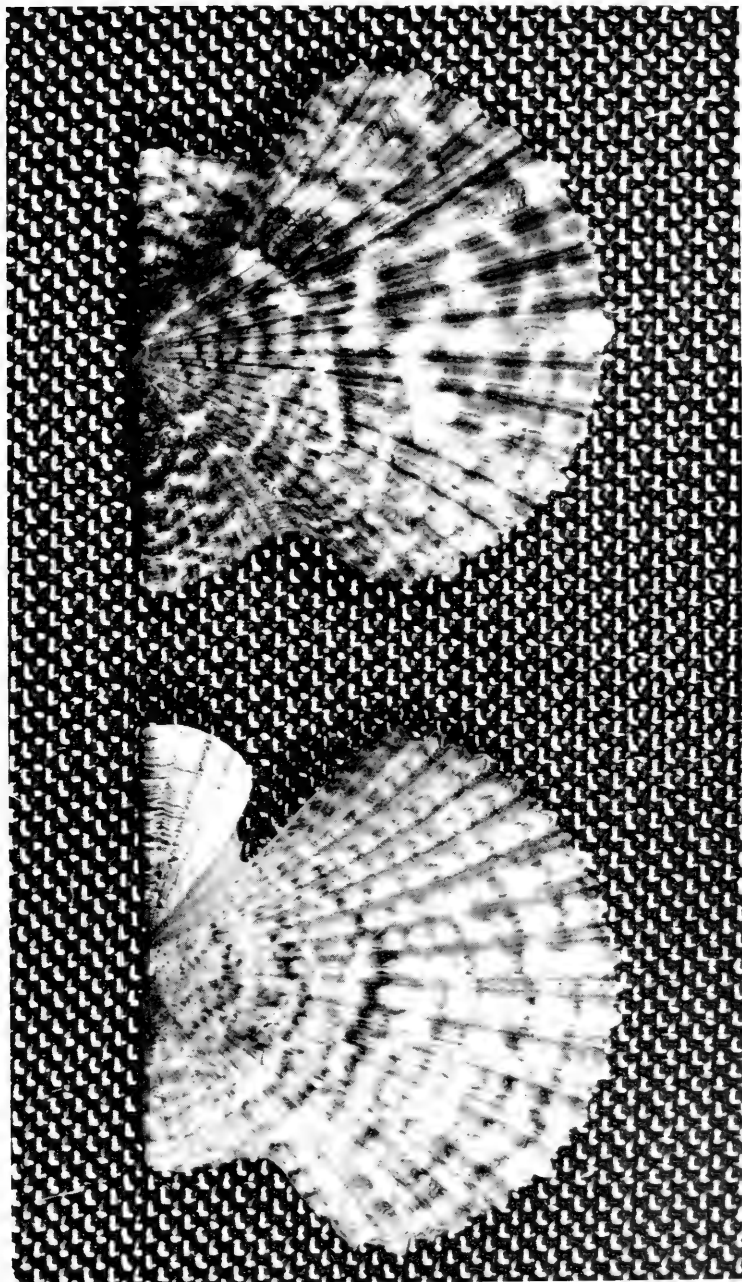


PLATE 38

Chlamys (Leptopecten) velero biolleyi (Hertlein and Strong), 1946.
Off Medidor Island, west Panama, in 40 fathoms. Height: 7 mm;
length: 8 mm. (Grau collection.) P.



PLATE 39

Chlamys (Leptopecten) euterpes (Berry), 1955. Paratype. Off Acapulco, west Mexico, in 6-10 fathoms. Height: 5 mm; length: 5.2 mm. (Grau collection.)

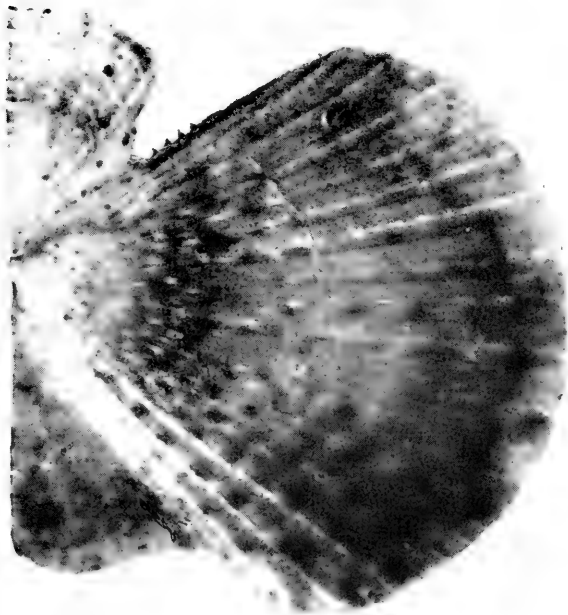
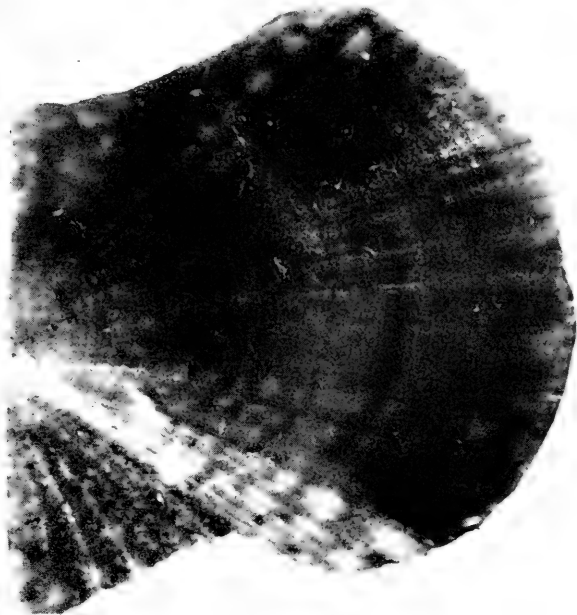


PLATE 40

Chlamys (Leptopecten) tumbezensis (d'Orbigny), 1846. Off Zorritos, Peru, in 15 fathoms. Height: 40 mm; length: 47 mm. (Grau collection.) P.

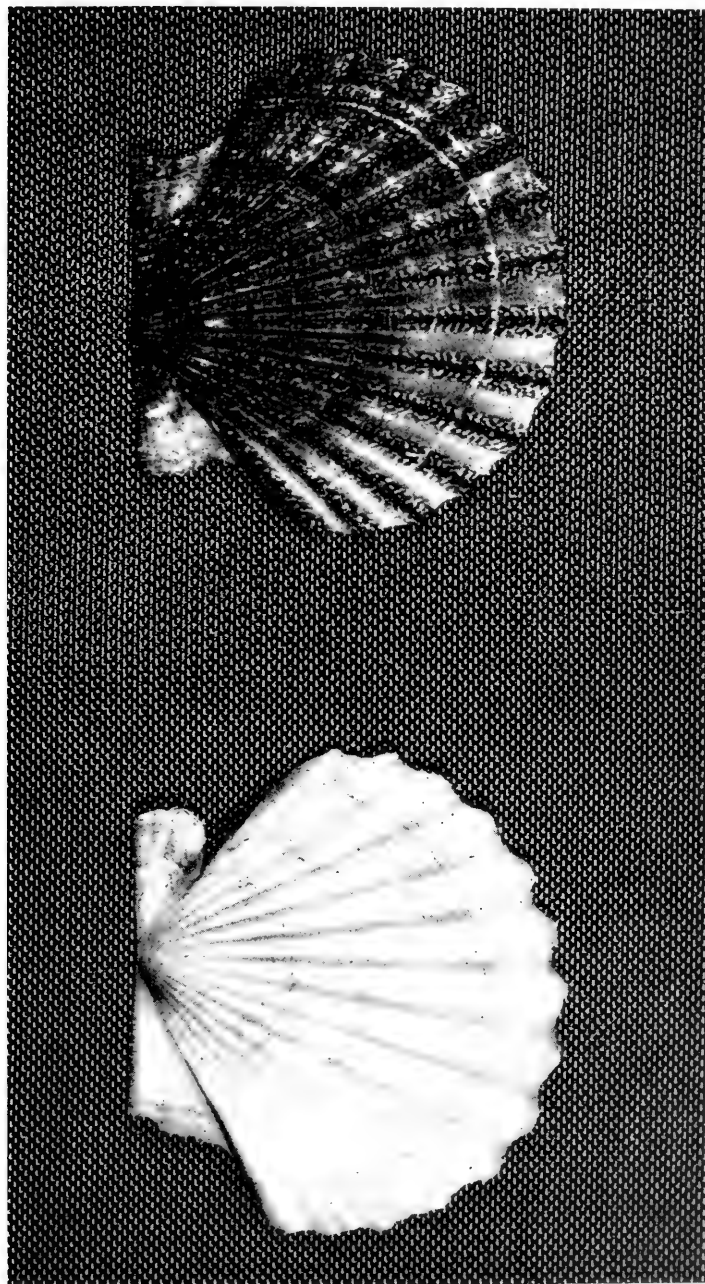
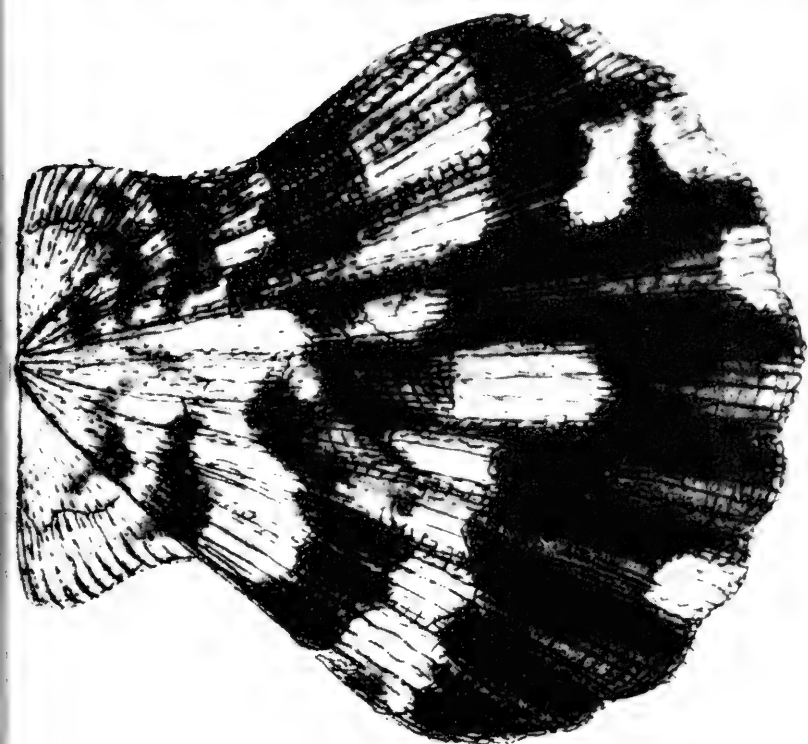
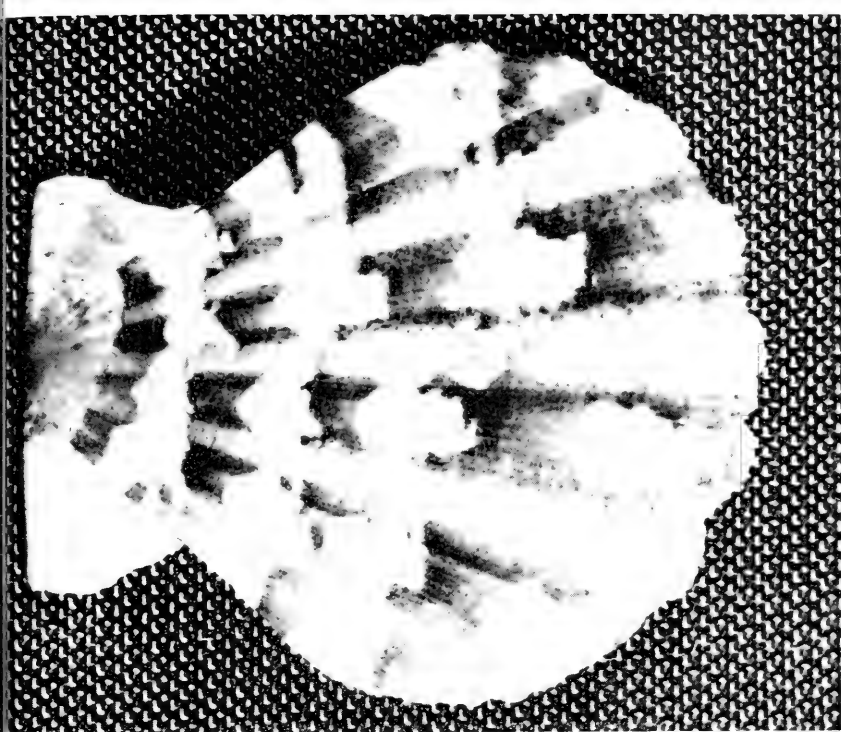


PLATE 41

- Fig. 1. *Semipallium zeteki* (Hertlein), 1935. (? = *Pecten vexillum* Reeve, 1853.) Reproduction of original figure of *Pecten digitatus* Hinds, 1945. P.
- Fig. 2. *Semipallium vexillum* (Reeve), 1853. Left valve of juvenile specimen, for comparison with fig. 1. Moorea, Society Islands. Height: 24 mm; length: 21 mm. (Grau collection.) P.



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PLATE 42

- Fig. 1. *Semipallium (Juxtamusium) natans* (Philippi), 1845.
Beagle Channel, Tierra del Fuego. Height: 28 mm; length:
26 mm. (Grau collection.) P.
- Fig. 2. Left valve of same species, same locality; most ribs medium
brown, a few uncolored.

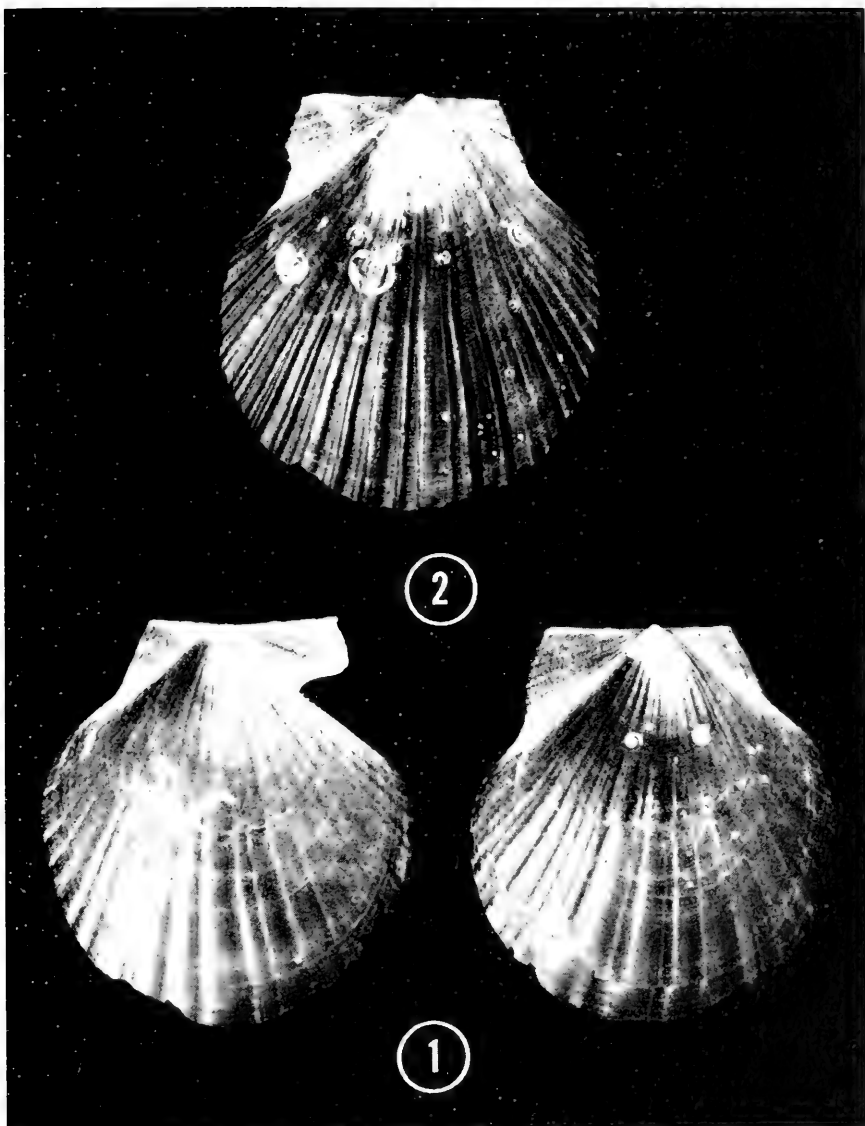


PLATE 43

Nodipecten subnodosus (Sowerby), 1835. La Paz, Lower California.
Height: 156 mm; length, 162 mm. (Grau collection.) P.

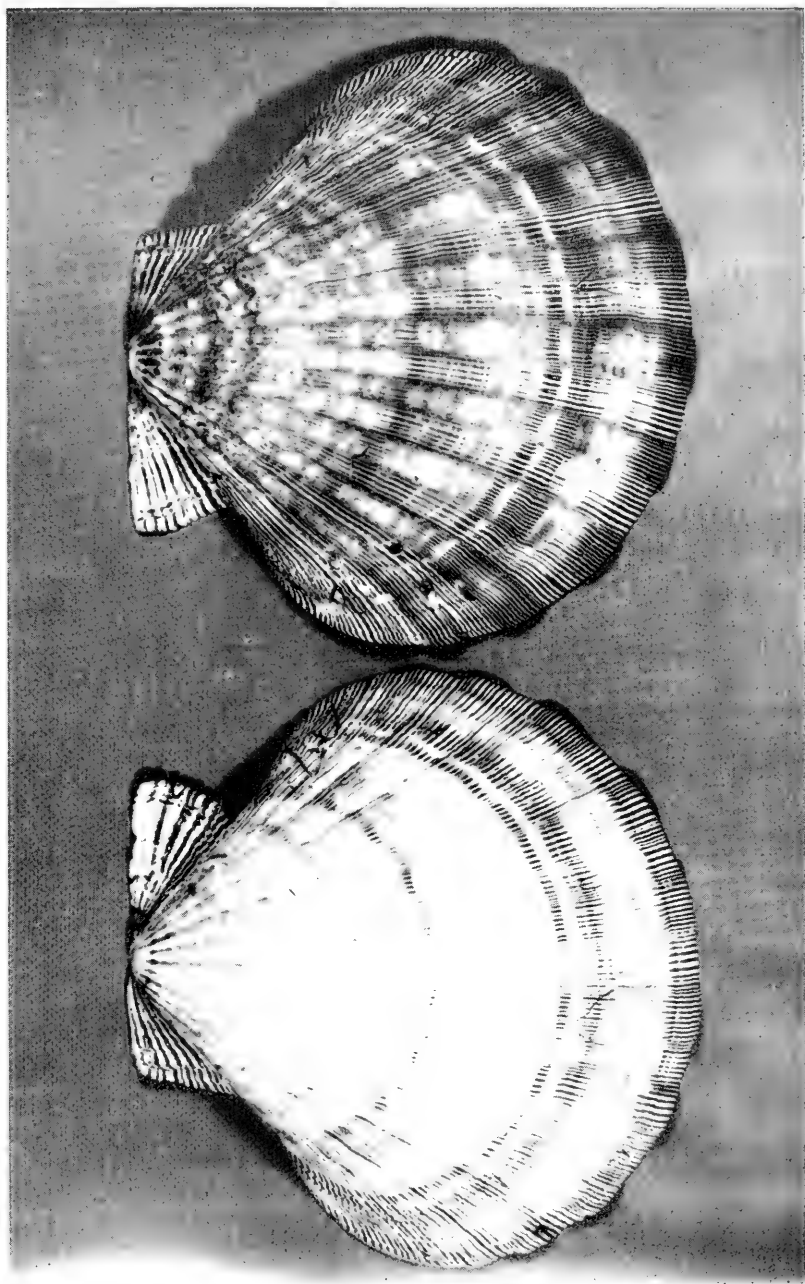


PLATE 44

Nodipecten magnificus (Sowerby), 1835. Narborough Island, Galapagos Islands, on pebbly beach opposite Tagus Cove, Albemarle Island. Length: 174 mm. (Stanford Univ. Paleo. Type collection, no. 440.) P.



PLATE 45

Hinnites multirugosus (Gale), 1928. Malibu Beach, California.
Height: 93 mm; length: 98 mm. (Grau collection.) P.



PLATE 46

Hinnites multirugosus (Gale), 1928. Santa Maria Bay, western Lower California. Height: 86 mm; length: 76 mm. (Grau collection.) P.

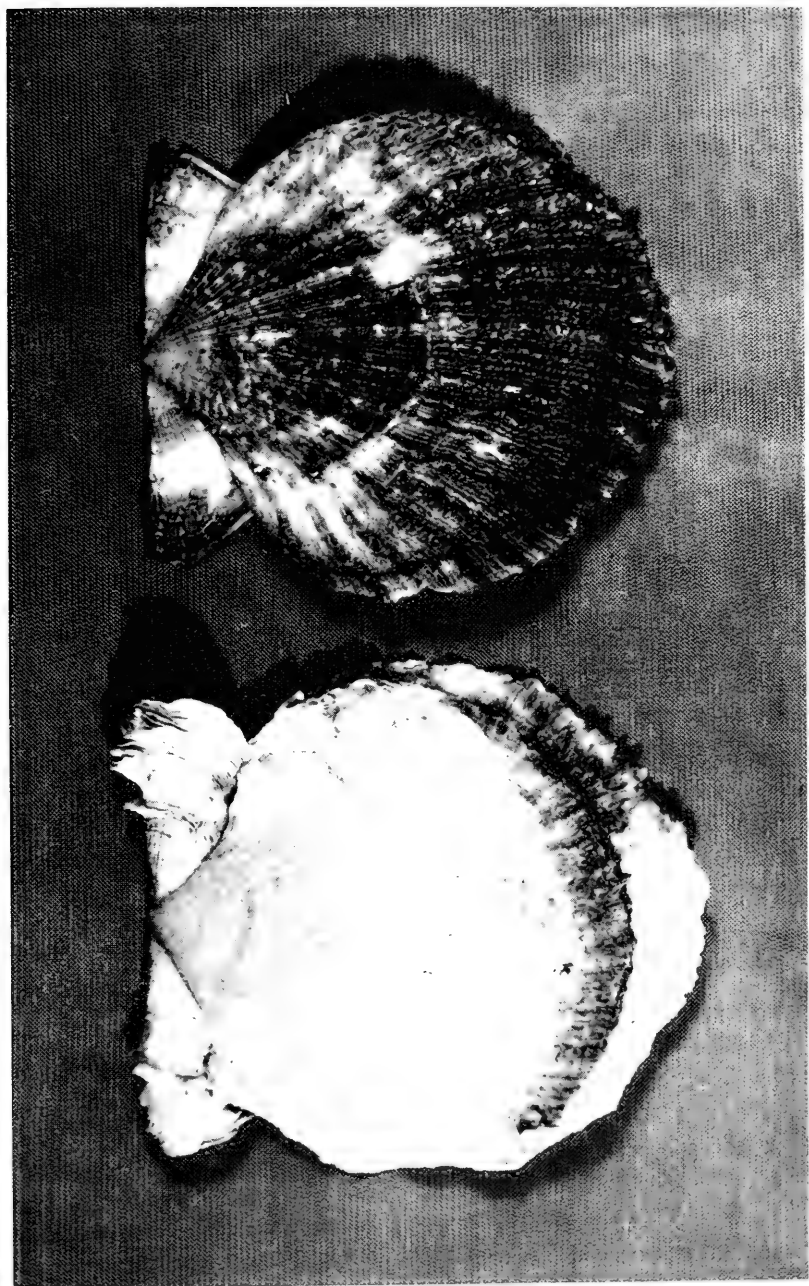


PLATE 47

Hinnites multirugosus (Gale), 1928. San Pedro, California. Height: 37 mm; length: 34 mm. (Grau collection.) P.

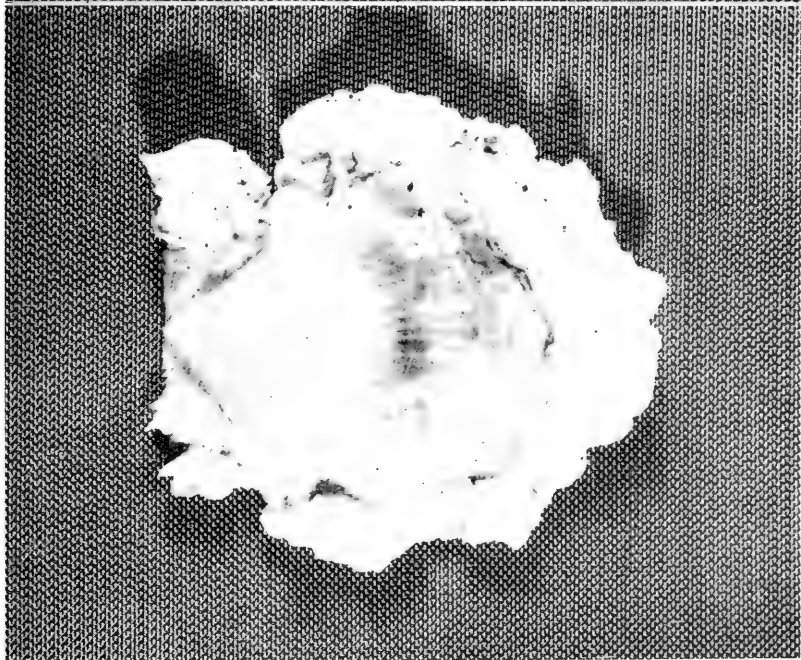
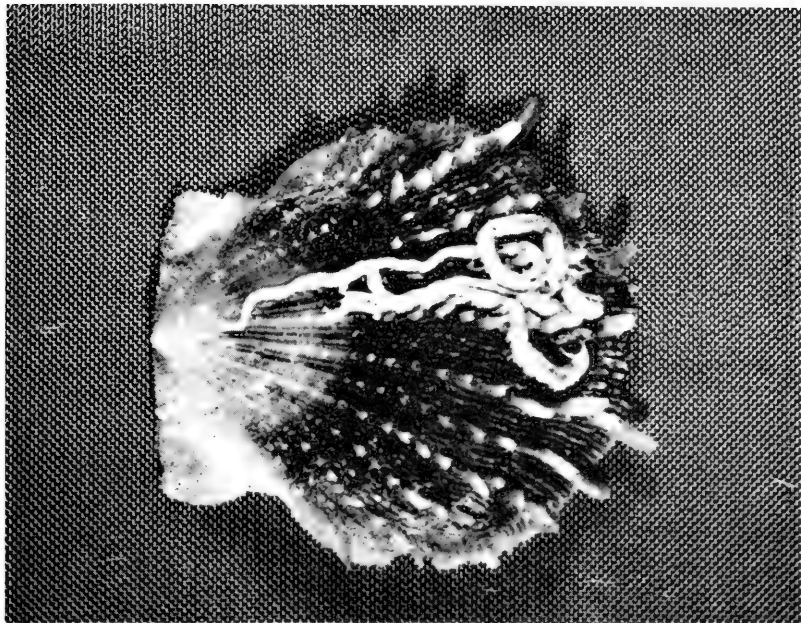


PLATE 48

Hinnites multirugosus (Gale), 1928. San Pedro, California. Height: 22 mm; length: 21 mm. (Grau collection.) P.

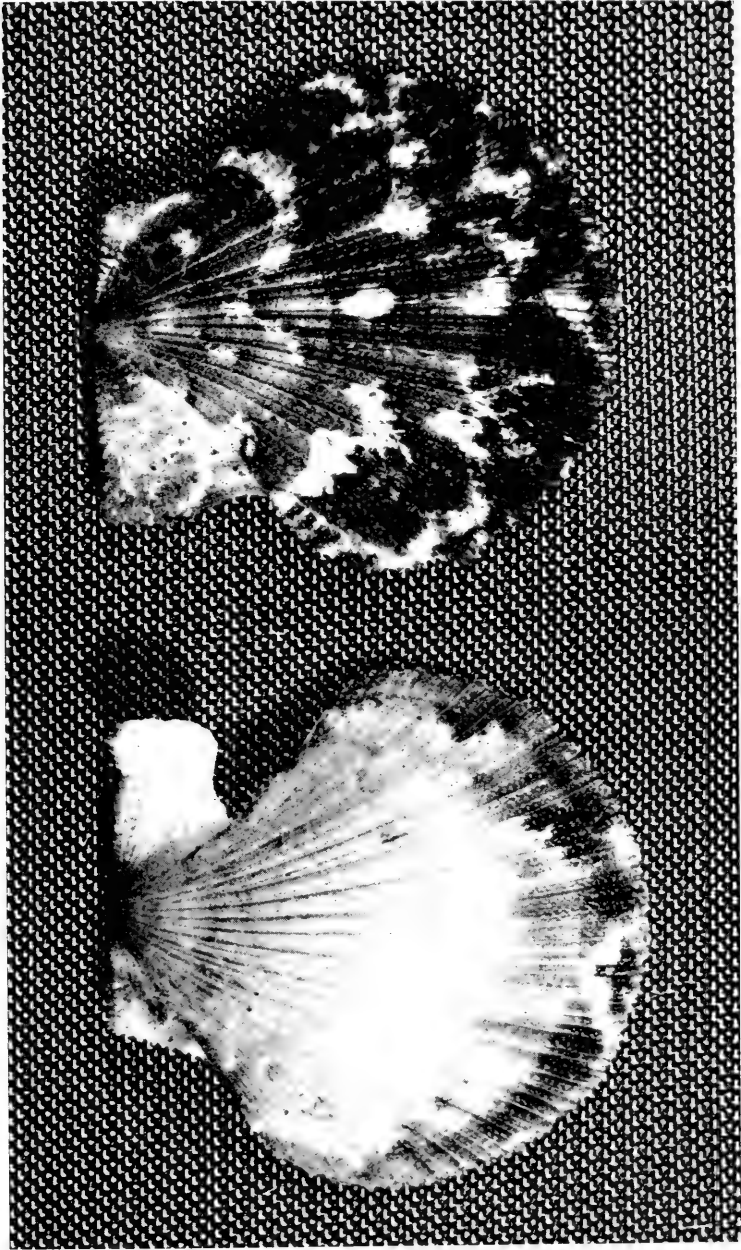


PLATE 49

Hinnites multirugosus (Gale), 1928. Very young specimen. San Pedro, California. Height: 7 mm; length: 6 mm. (Grau collection.)
P.

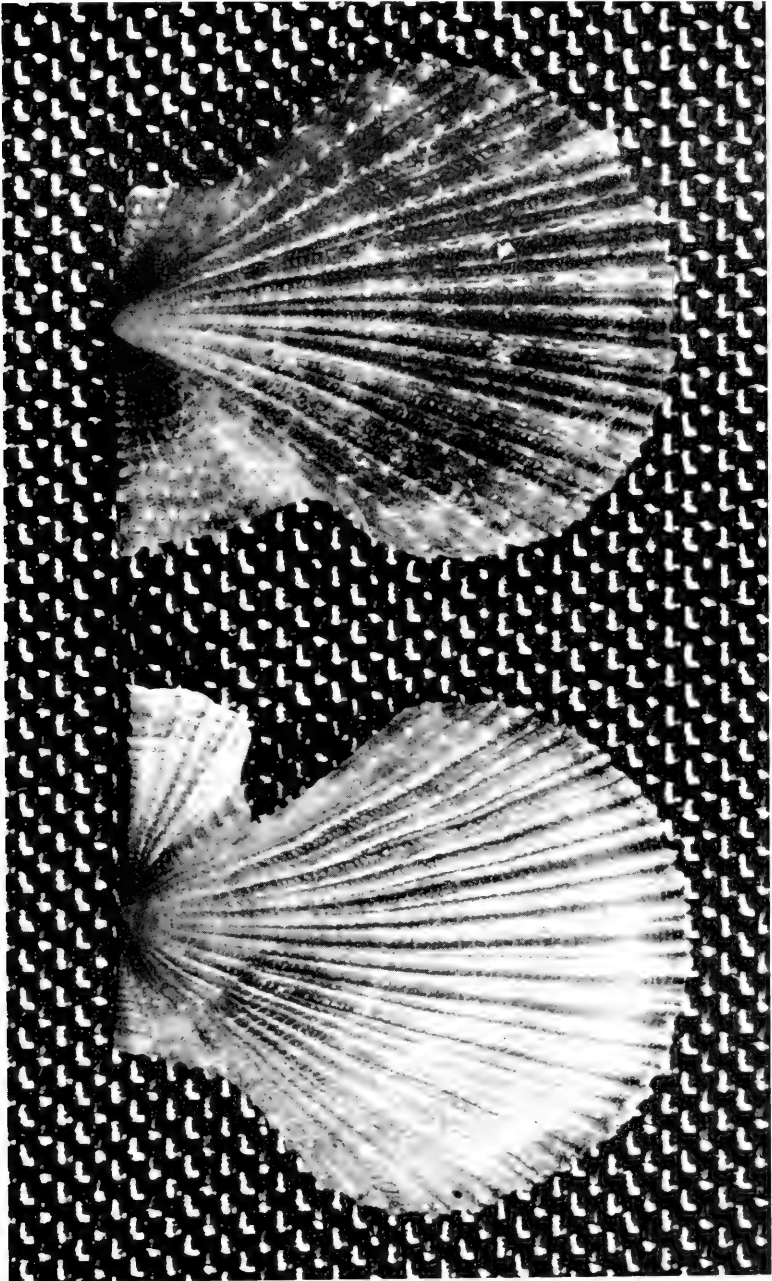


PLATE 50

Pecten sericeus Hinds, 1845. Off San Felipe Bay, Gulf of California, in 80 fathoms. Height: 62 mm; length: 70 mm. (Grau collection.)
P.



PLATE 51

Pecten sericeus Hinds, 1845. Adolescent specimen. Banderas Bay, Jalisco, west Mexico, in 50 fathoms. Height: 45 mm; length: 47 mm. (Grau collection.) P.

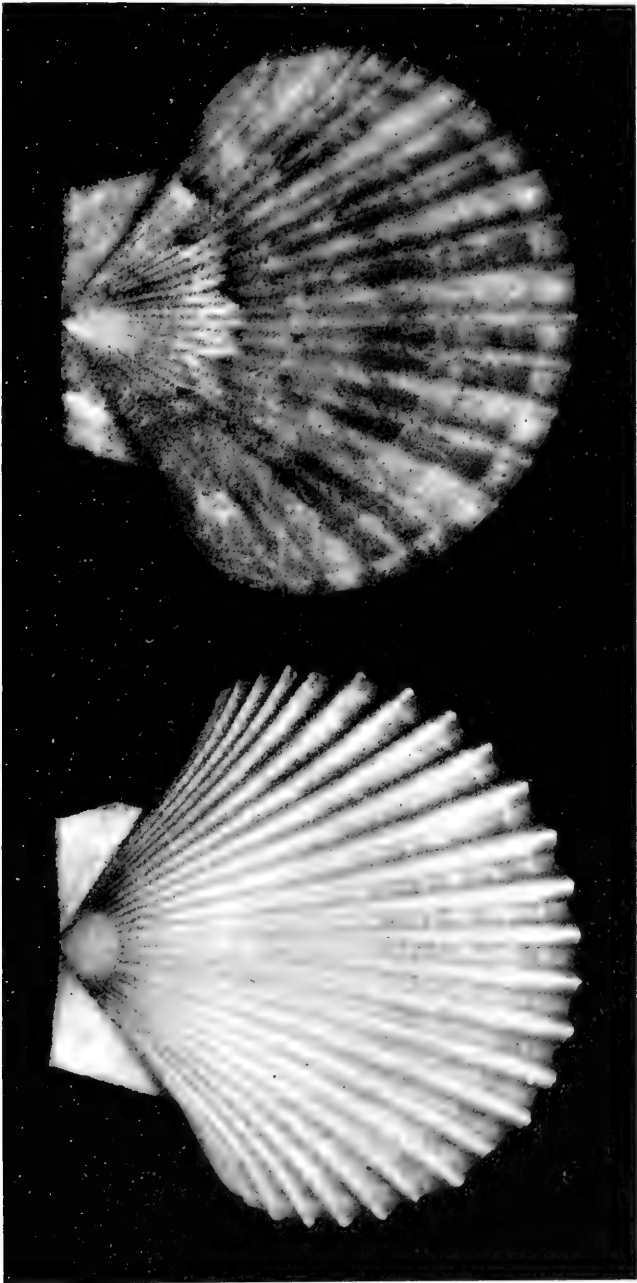


PLATE 52

Pecten diegensis Dall, 1898. Off San Diego, California, in 40 fathoms. Height: 83 mm; length: 97 mm. (Grau collection.) P.

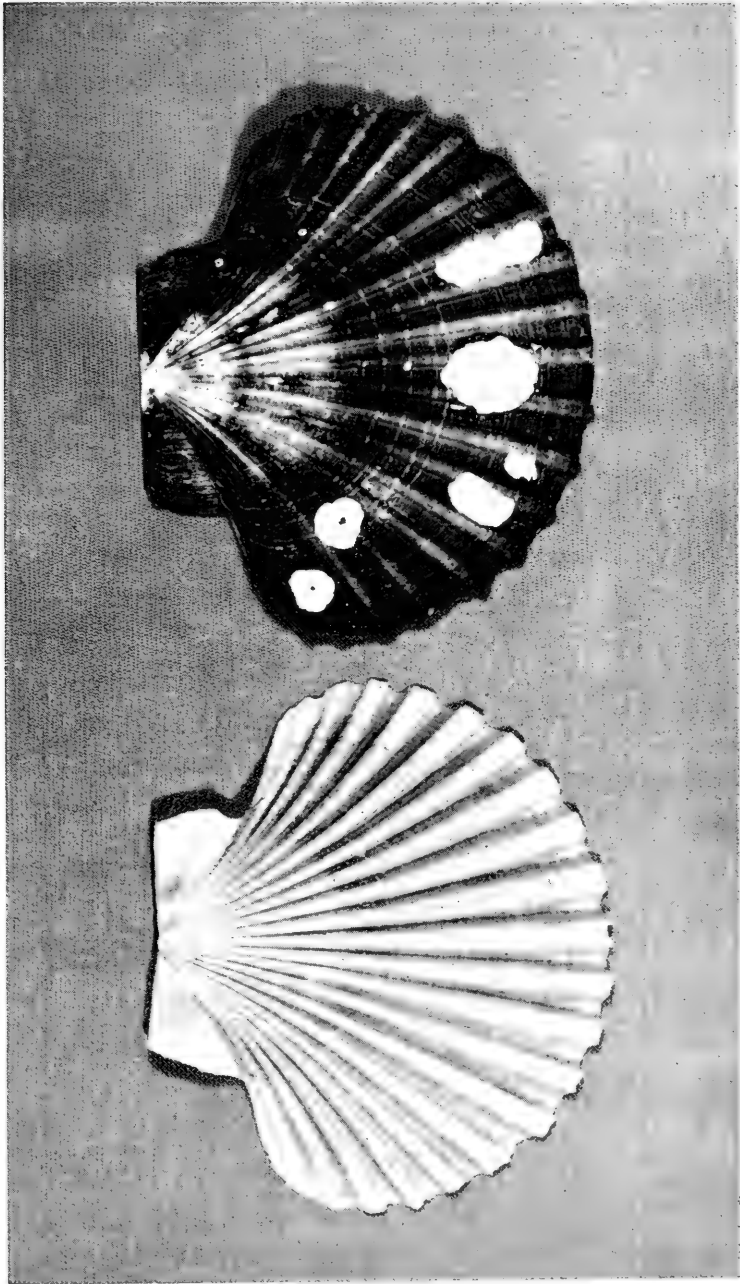


PLATE 53

Pecten diegensis Dall, 1898. Adolescent specimen. Off Santa Catalina Island, California, in 25 fathoms. Height: 45 mm; length: 51 mm. (Grau collection.) P.

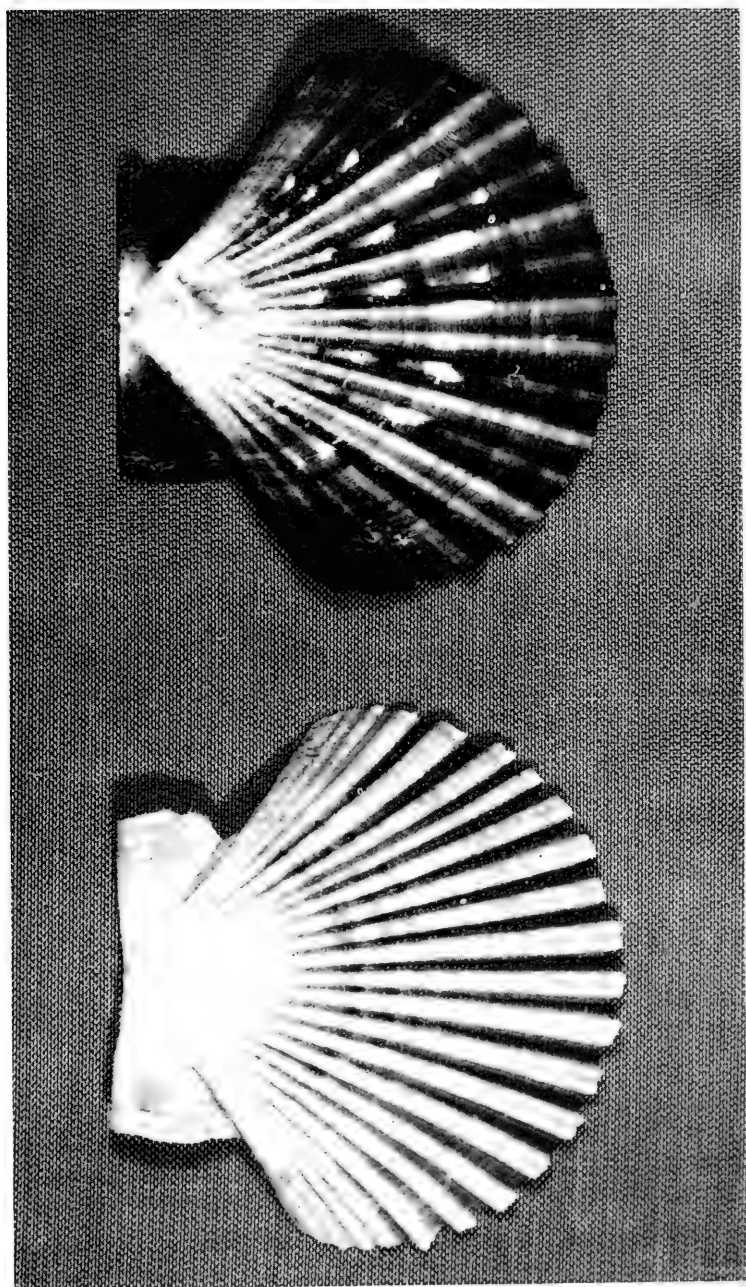


PLATE 54

Pecten (Patinopecten) caurinus Gould, 1850. Off Eureka, California, in 37 fathoms. Height and length: 130 mm. (Grau collection.) P.

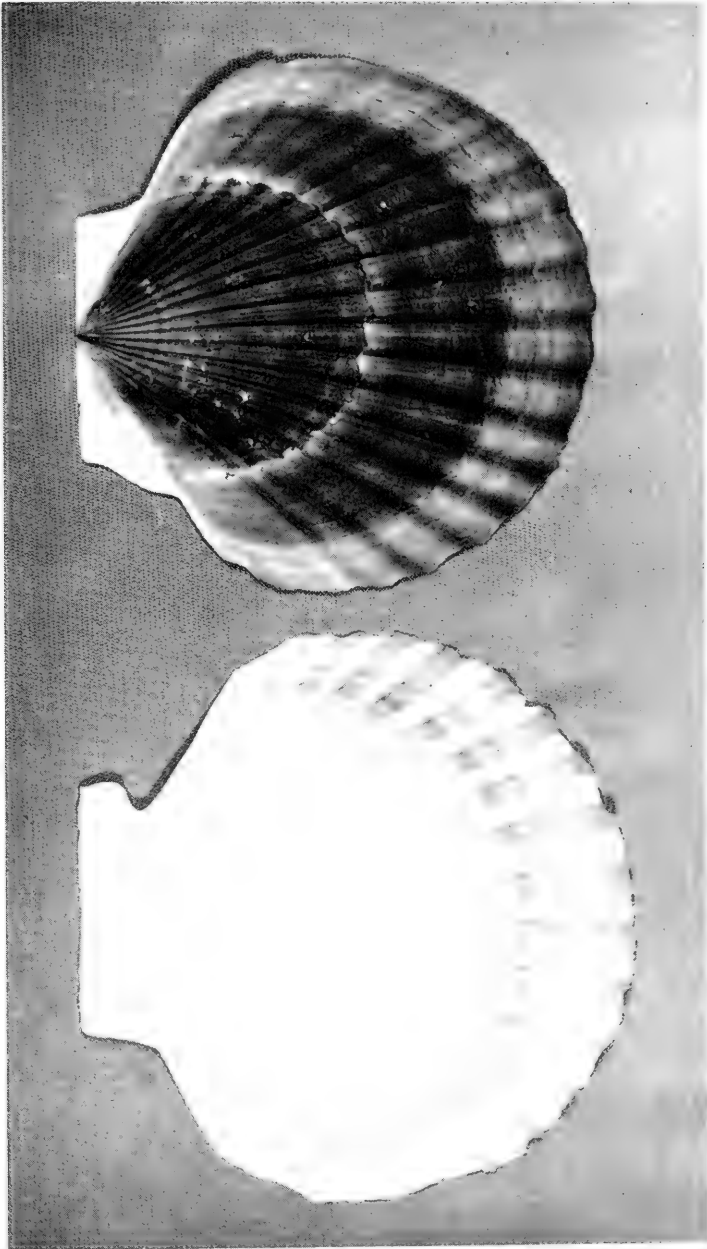


PLATE 55

Pecten (Oppenheimopecten) vogdesi Arnold, 1906. Concepcion Bay, Gulf of California, in 25 fathoms. Height: 88 mm; length: 99 mm. (Grau collection.) P.

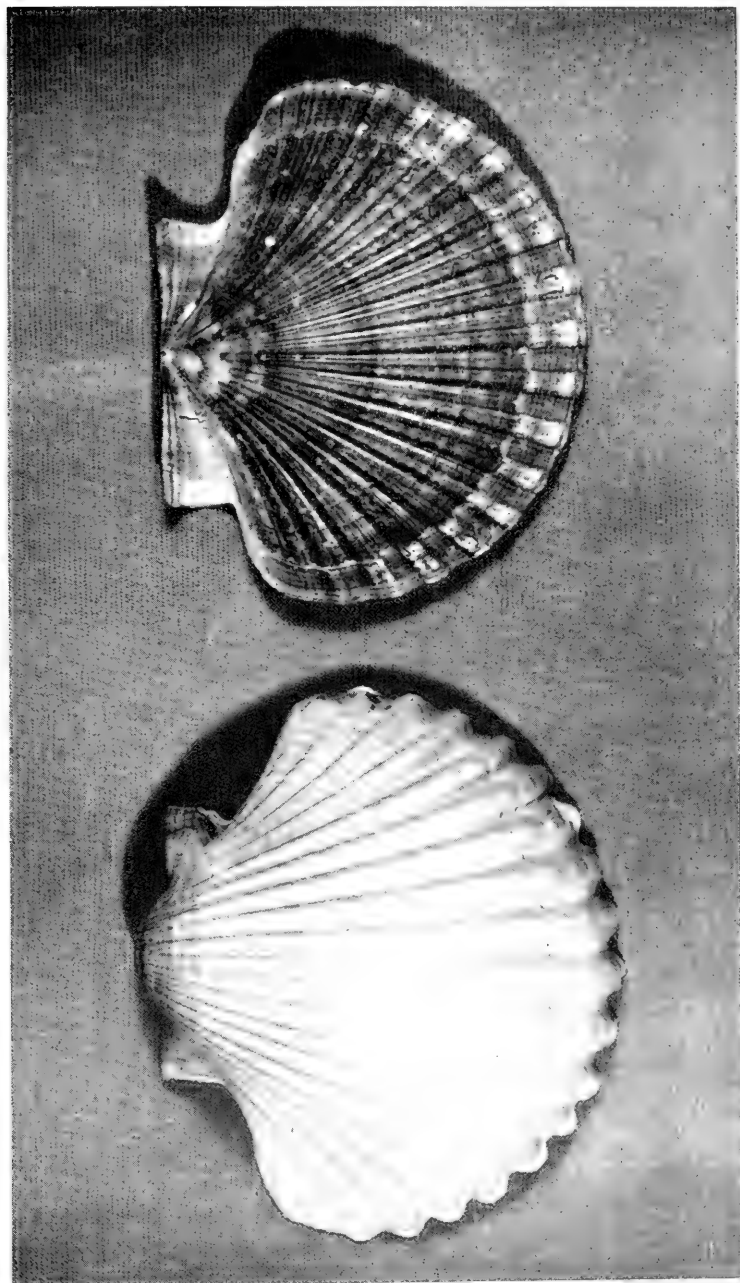


PLATE 56

Pecten (Oppenheimerpecten) galapagensis sp. nov. Hancock expeditions station 157-34, Tagus Cove, Albemarle Island, Galapagos Islands, in 10-18 fathoms. Height: 44 mm; length: 49 mm. (Hancock Foundation collection.) P.

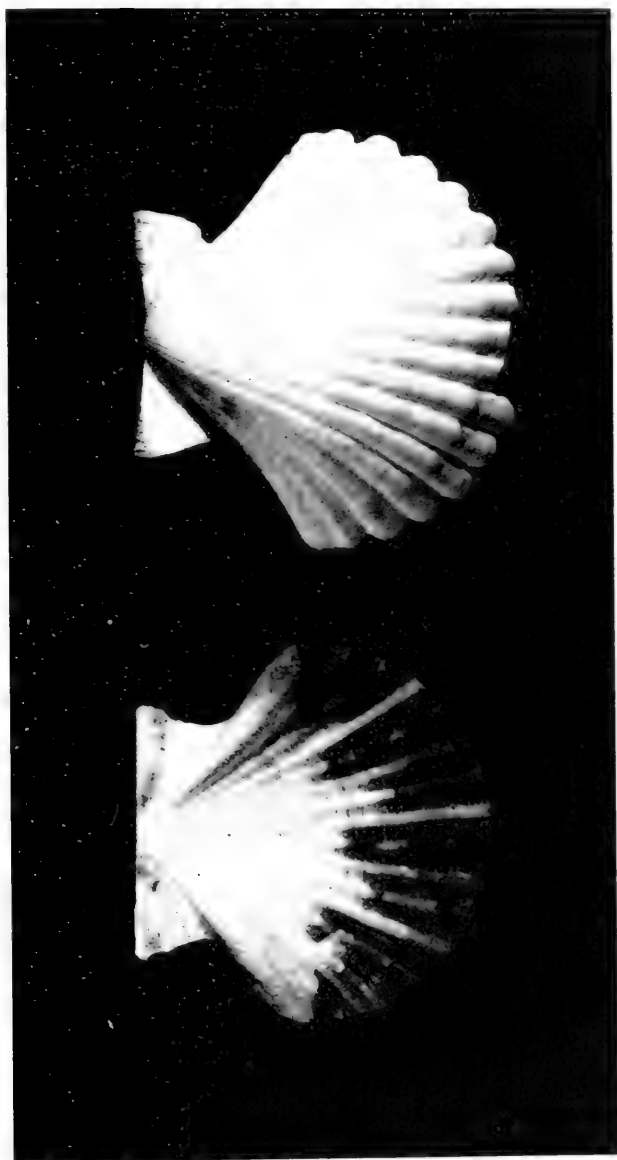
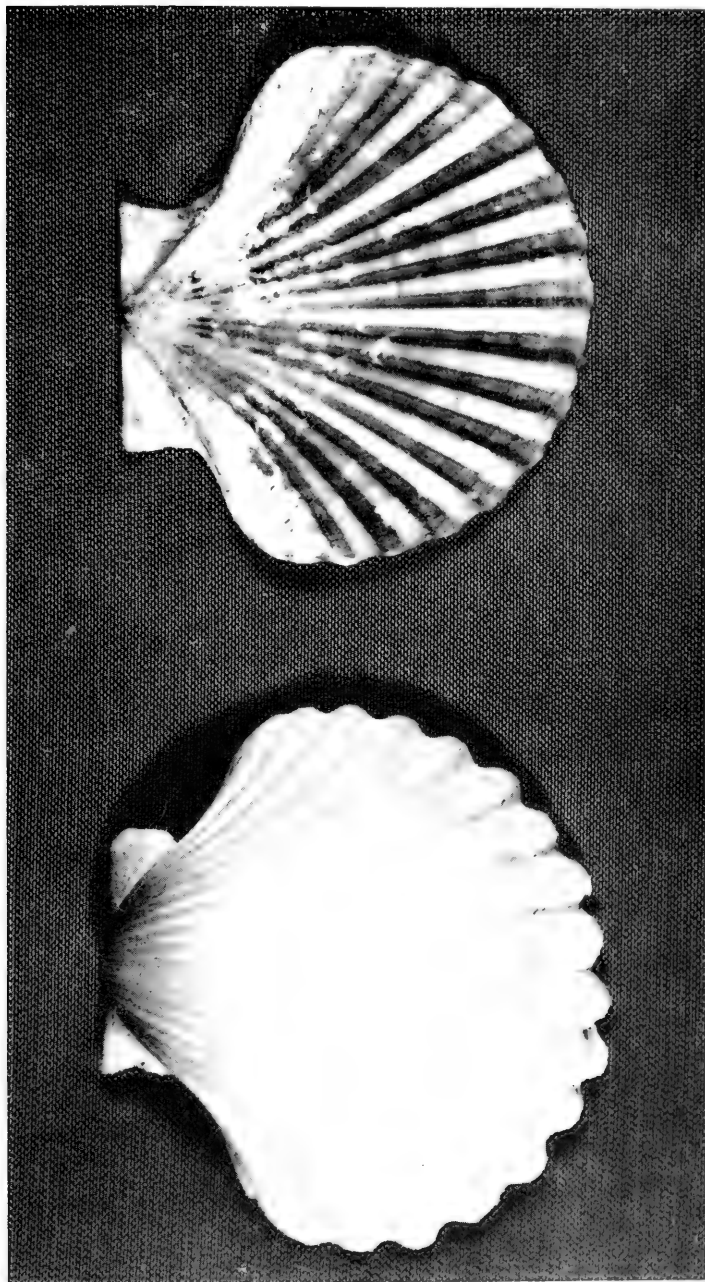


PLATE 57

Pecten (Oppenheimopecten) hancocki sp. nov. Hancock expeditions station 780b-38, Chatham Bay, Cocos Island, Costa Rica, in 47 fathoms. Height: 47 mm; length: 49 mm. (Hancock Foundation collection.) P.





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